FEDERAL HIGHWAY ADMINISTRATION EASTERN FEDERAL LANDS HIGHWAY DIVISION

SOILS AND FOUNDATION REPORT

FINAL 100% SUBMITTAL

REHABILITATION OF PARK ROADS
FOR BLUE RIDGE PARKWAY
YANCEY AND BUNCOMBE
COUNTIES, NORTH CAROLINA

PRA-BLRI 2P14
CONTRACT NO. DTFH71-02-D-00004
TASK ORDER 0003

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Table of Contents

Background	**1**
Project Area	**1**
Overview	1
Regional Geology	2
Procedures and Results	**3**
Pavement Condition Survey	3
Soil Borings	5
Sampling	6
Field Tests and Measurements	7
Laboratory Testing	10
Data Summary	15
Pavement Design	15
Supplemental Investigation	**18**
Recommendations	**20**
Earthwork	20
Aggregate Base Course	20
Pavement Section	20
Craggy Dome Retaining Wall	20
References	**22**

Table of Contents

Tables

1	Summary of Pavement Condition Survey
2	Summary of DCP Tests Results
3	Summary of Laboratory Tests Results
4	Asphalt Pavement Properties
5	Hot Mix Asphalt Properties – Surface Course Layer
6	Hot Mix Asphalt Properties – Binder/Base Course Layer
7	Typical Sections for Repair
8	Recommended Sections and Repairs
9	Laboratory Test Results for Existing Base Material

Figures

1	Project Location Map
2-12	Boring Location Maps
13	Geologic Map

Appendices

A	Project Maps
B	Project Photographs
C	Boring Logs
D	Field Test Results
E	DCP Testing
F	FWD Testing
G	Laboratory Test Results
H	Pavement Design Analysis

Background

Blue Ridge Parkway is a 469-mile scenic corridor that connects Shenandoah Valley in Virginia to the Great Smoky Mountains National Park in North Carolina. Adjacent to the parkway, which ranges in elevation from 649 feet to 6,047 feet, are recreational areas that include picnic facilities, hiking trails, visitor centers, overlooks, and campgrounds.

The Blue Ridge Parkway, conceived as a Depression-relief project in the 1930s, took more than 50 years to construct. The parkway is frequented by visitors who come to enjoy the vistas and the foliage and a number of citizen groups concerned with maintaining the pristine nature of the mountain ranges traversed by the Parkway.

The pavement along Blue Ridge Parkway and adjacent access roads and pull-offs is in various stages of deterioration and in need of rehabilitation. Area features such as asphalt paths, granite curbs, rubble and masonry walls and steps are also in need of repair. The project, referred to as Section 2P, consists of the rehabilitation of the parkway pavement between Milepost 359.8, at the Balsam Gap Overlook, and Milepost 375.3. Also included is the reconstruction, replacement, or rehabilitation of ditches, pipes, walls, sidewalks, and curbs.

The Blue Ridge Parkway project is for the Eastern Federal Lands Highway Division (EFLHD) of the Federal Highway Administration (FHWA) of the U.S. Department of Transportation and the U.S. National Park Service (NPS). The Blue Ridge Parkway is used by thousands of tourists every year and special consideration will be made to ensure that the overlooks, visitors center, and the parkway itself remain accessible at all times.

The purpose of this report is to document the findings of the subsurface investigations and to present geotechnical recommendations.

Project Area

Overview

Within Section 2P, there are six parking and pull-off areas, one picnic parking area with a 1.2-mile access road referred to as Craggy Garden, a visitor's center parking area located along Section 2P at approximately Mile 364.6, and three tunnels that have already been reconditioned. Along with the roadway and parking areas, three areas of potential embankment instability were observed during project development. These areas are located at mileposts 361.8, 362.8, and 363.4. Within the project limits, the average roadway width is 22 feet and the length is approximately 15.5 miles long. Appendix A contains all the figures for this report. Figure 1 presents a Project Location Map. Figures 2 through 12 present more detailed plans showing the roadway, Visitor's Center, picnic areas, and pull-offs.

Regional Geology

Section 2P lies within the Blue Ridge physiographic province east of the French Broad River and west of Mount Mitchell. Figure 13 in Appendix A illustrates the geologic map prepared for this section. The Blue Ridge physiographic province resulted from a series of mountain building (orogeny) and metamorphic events beginning with the Grenville Orogeny, 1,000 million years ago (mya), and culminating with the Alleghanian Orogeny (300-245 mya).[1] Cycles of continental collision and rifting resulted in a structurally complex group of ultramafic and mafic rocks, and high-grade metamorphic rocks.

The geology of the area is predominantly the Ashe Metamorphic Suite (AMS) containing a series of layered mica gneiss, quartz-feldspar gneiss, mica schist, pegmatite, amphibolites, and eclogites. The gneiss and schist are interpreted as metamorphosed conglomerates and sandstones. The amphibolites are interpreted as metamorphosed basalt (volcanic rock).[2] The eclogites are interpreted as metamorphosed rocks that were part of an accretionary wedge of a convergent continent.[3] The schist, gneiss, and amphibolites are the result of low-to-moderate pressure and moderate-to-high temperature conditions. The eclogites were exposed to high pressure and moderate-to-high temperature conditions. The above pressure – temperature environments are consistent with continental collision events.

The AMS is in the hanging wall (the thrust sheet above the plane of the fault) of the Holland Mountain Fault (HMF), which trends northeast-southwest in this area and dips to the southeast. Thrusts faults are low angle (less than 30 degrees) reverse faults. These faults are shown as single traces on geologic maps; however, in the field they occur as a series of faults and splays rather than a single expression. Within the hanging wall of the HMF is the Burnsville Fault, which roughly parallels (separation approximately 4 miles) the HMF in this study area. The Burnsville Fault was thought to be a thrust fault as shown on the geologic map. Recently the fault has been reinterpreted as a dextral strike-slip shear zone, which is the boundary between the Pumpkin Patch thrust sheet to the west and Spruce Pine thrust sheet to the east.[4] The studied section lies within the Spruce Pine thrust sheet southeast of the Burnsville Fault approximately 20 miles south of Burnsville, North Carolina.

Procedures and Results

Pavement Condition Survey

The initial task of the geotechnical investigation was to conduct a pavement condition survey of Section 2P, including overlooks, the picnic area parking, and access road. This survey was conducted to help determine initial areas of concern and to help produce the most efficient layout of the borings. Evaluation techniques and severity levels used were the same as those from previous FHWA studies. Photographs of typical distresses are located in Appendix B.

The field survey examined five major categories of distress: transverse cracking, fatigue cracking, rutting, patches, and block cracking. The survey data is listed by milepost and is presented in Table 1.

TABLE 1

Summary of Pavement Condition Survey

Mile Post	Cracking: No. of Transverse Cracks	Cracking: Fatigue (% Surface Area)			Rutting (% Surface Area)			Number of Patches			Block Crackin g %
		L	M	H	L	M	H	S	M	L	
359.8	4										
360	5				2						
361	10	2						2	2	1	
362	9	2						3			
363	15	3						4	1	1	
364	54	16	8	2		1		12	1	1	
365	41	14	14	1	4			23	5	4	
366	77	37	36	2	5	1		28	5	4	
367	65	41	26	0.8				26	9	2	
368	6	25	9	0.3				16	4	3	
369	49	19	3	0.5	1.3			16	5	2	2.3
370	72	18	4	0.6	4			10	3	1	
371	46	36	22		10			38	11	5	
372	64	46	28	5	7			58	13	13	3

TABLE 1 (cont.)

Summary of Pavement Condition Survey

Mile Post	Cracking: No. of Transverse Cracks	Cracking: Fatigue (% Surface Area) L	M	H	Rutting (% Surface Area) L	M	H	Number of Patches S	M	L	Block Cracking %
373	30	34	38	11	16			89	19	20	15
374	61	12	23	13	15	2		65	13	9	24
375.3	6	12	5					1		1	83
Picnic Road	51	20	0.3	0.3					3		
Visitor Center	Approximately 1,700 linear feet of block and thermal cracking.										
Craggy Dome	Approximately 3,000 linear feet of block and thermal cracking.										
Picnic Parking	Approximately 2,800 linear feet of block and thermal cracking.										
Graybeard Overlook	Block cracking with 10- to 12-foot centers.										
Balsam Gap	Block and thermal cracking with 10-foot centers.										
Lane Pinnacle	Approximately 500 linear feet of thermal cracks.										
Bull Creek Valley	Approximately 350 linear feet of transverse and block cracking.										
Glassmine Falls	Approximately 545 linear feet of block and thermal cracking.										

Transverse cracking was measured by counting the total number of transverse cracks per mile within each section. In order to speed the rate of information collection, transverse cracks were only counted if the crack was greater than ¼ inch in width.

Fatigue cracking was measured by percent surface area of the mile in which it occurred. Fatigue cracking was categorized into three severity levels: low (L), moderate (M), and high (H). The severity levels were based on example photographs and descriptions in the Strategic Highway Research Program (SHRP) publication, *Distress Identification Manual for the Long-Term Pavement Performance Project.*

Rutting was measured in three severity levels: low, moderate, and high. Each severity level was measured in percent surface area of the mile in which it occurred. The three severity levels are based on rut depth and are defined as follows:

low = 0 to 0.5 inch deep
moderate = 0.5 to 1.5 inches deep
high = 1.5 inches and greater deep

Patches were counted and totaled for each mile in three categories of severity: small, medium, and large. The patches category includes other forms of distress, such as potholes and depressions. The severity levels were based on the square feet of the affected surface area, as follows:

small (S) = 9 square feet and less
medium (M) = 9 square feet to 50 square feet
large (L) = 50 square feet and greater

Similar to fatigue cracking, block cracking was measured by percent surface area of the mile in which it occurred. No severity levels are associated with block cracking.

Longitudinal cracking was not one of the major categories of distress investigated, but minor quantities of low-severity longitudinal cracking were identified.

The pullouts and overlooks were generally surveyed by their distress category, and the total length of cracking was measured with a survey wheel.

Soil Borings

The soil boring program consisted of borings with Standard Penetration Test (SPT) and Dynamic Cone Penetrometer (DCP) testing for pavement and subgrade evaluation. The soil borings were drilled by S&ME, Inc., of Knoxville, Tennessee. Burns Cooley Dennis Inc., of Jackson, Mississippi, performed the DCP testing. The shallow borings were generally drilled and sampled to a depth of 4 feet below ground surface (BGS). Early refusal (before the 4-foot depth) was encountered in 14 of the 39 shallow borings.

A total of 45 borings were drilled in the project pavements and provided data for correlation with non-destructive testing (NDT) and investigation of conditions at representative locations. Borings were generally spaced along the roadway at approximately ½-mile intervals. The final locations were determined based on the results of the condition survey and consideration of high-severity distress areas. Pavement, base, and subgrade materials were evaluated.

Each boring included drilling through the asphalt concrete surface. Eight 6-inch asphalt cores were recovered at various locations along the project. Continuous SPT in accordance with American Association of State Highway and Transportation Officials (AASHTO) T-206 were taken in 13 borings for an estimated 3 feet below the aggregate base (i.e., two 1.5-foot SPT samples) to determine the type and thickness of subbase and to determine subgrade conditions. If large gravel or rock fragments in the pavement subbase prevented using SPT or DCP, the subbase was augered through and evaluated visually based on auger returns. Auger refusal was encountered in 12 borings within the scope of the investigation. Boring logs are presented in Appendix C.

The DCP testing was performed in 29 borings to evaluate in-situ subgrade strengths. The DCP testing was conducted to a depth of approximately 3 feet below the pavement surface. Based on a correlation developed by the U.S. Army Corps of Engineers Waterways Experiment Station, the DCP penetration and blow count data were converted to California Bearing Ratios (CBR). Results of the DCP testing are located in Appendix D.

At mileposts 361.8, 362.8, and 363.4, two additional borings, each on either side of the pavement, were drilled to an average depth of 28 feet. Due to the boulder fill under the roadway, these borings were advanced by rock coring methods. Once solid rock was encountered, a run of 5 to 10 feet was cored. Due to the boulder fill no undisturbed samples (AASHTO T-207) were taken.

Boring abandonment was based on two categories: more than 5 feet and less than 5 feet in depth. Borings more than 5 feet were backfilled with tamped cuttings to within 2 feet of the existing subgrade. A plastic hole plug was then compacted in the hole. Asphalt cold patch was placed at least as thick as the existing roadway, and in many cases thicker, to replace the hard pavement surface and was crowned to allow for settling and to redirect rainfall away from the borehole. Borings less than 5 feet were closed using the same method except that the plastic hole plug was omitted.

Sampling

Material sampling was conducted in borings B-1 through B-40 as the borings were advanced. Sampling was typically conducted continuously after the top 1 foot. Soil samples were recovered with a 2¼-inch-outside-diameter split-barrel sampler in accordance with AASHTO T200-87. Representative portions of recovered samples were preserved in glass jars for laboratory testing. The sampling sequence for the borings is summarized on the boring logs in Appendix B.

Field Tests and Measurements

During the subsurface investigation, the geotechnical field crews conducted the following field tests and measurements:

Standard Penetration Testing (SPT)
Dynamic Cone Penetration (DCP) Testing
Falling Weight Deflectometer (FWD) Testing

As previously mentioned, SPT was performed in accordance with AASHTO T206-87. The SPT sampler was driven into the subgrade using a 140-pound hammer falling 30 inches. Sample recovery measurements were made and recorded for each sampling attempt. A field description by color and texture was made for each recovered sample.

Dynamic cone penetration was used to conduct in-situ testing of subgrade materials at 29 selected locations. The DCP testing was conducted to depths ranging between 1 foot and 3 feet below the asphalt pavement surface. Due to the significant amount of rock fragments in the subgrade materials, the depth of many DCP tests was limited. Based on a correlation developed by the U.S. Army Corps of Engineers, the DCP penetration data were converted to California Bearing Ratio (CBR). A summary of the DCP test results is presented in Table 2. Plots illustrating the computed variation in CBR with depth below the pavement surface are provided in Appendix D. The DCP testing report is provided in Appendix E. The presence of large gravel and boulders influenced many of the DCP tests. Those CBR values indicated as "100+" are generally the result of boulders in the subgrade.

TABLE 2
Summary of DCP Tests Results

Mile, Station (Boring No.)	Depth Intervals (inches)	Average CBR Values
359 41+50 (B-1)	10-15	40
	15-20	6
	20-32	3
360 50+00 (B-2)	10-16	20
	>16	100+
362 10+50 (B-4)	9-12	30
	>12	100+
	24-29	1.5
	29-34	8

TABLE 2 (cont.)

Summary of DCP Tests Results

Mile, Station (Boring No.)	Depth Intervals (inches)	Average CBR Values
362 23+00 (B-5)	8-10	50
	>10	100+
	30-40	2.5
362 51+00 (B-6)	7-18	30
	>18	100+
	34-38	40
363 10+50 (B-7)	10-17	35
	>17	100+
363 34+00 (B-8)	7-11	35
	>11	100+
367 21+50 (B-15)	>10	80
	>12	100+
367 39+00 (B-16)	5-10	40
	10-15	25
	15-23	10
	23-29	40
	>29	100+
368 12+50 (B-17)	10-24	25
	24-40	8
368 38+00 (B-18)	14-17	40
	>17	100+
369 4+50 (B-19)	>11	100+
369 14+00 (B-20)	11-14	40
	>14	100+
369 39+00 (B-21)	8-11	35
	>11	100+
370 13+00 (B-22)	8-11	70
	>11	100+
370 38+00 (B-23)	10-16	70
	>16	100+
371 15+00 (B-24)	10-28	30
	>28	100+

TABLE 2 (cont.) Summary of DCP Tests Results		
Mile, Station (Boring No.)	**Depth Intervals (inches)**	**Average CBR Values**
371 30+00 (B-26)	>12	20
	>14	100+
372 14+00 (B-27)	6-14	35
	14-21	20
	>21	100+
373 17+00 (B-29)	9-26	20
	26-33	50
373 37+00 (B-30)	11-15	4
	15-28	6
	>28	100+
374 36+00 (B-32)	11-22	10
	>24	100+
375 0+00 (B-33)	>8	100+
	12-14	40
	>14	100+
PA 20+50 (B-34)	4-10	25
	>10	100+
PA 36+80 (B-35)	6-12	4
	12-40	1
Picnic Parking (B-PA)	8-32	50
Craggy Dome Lower (B-CDL)	16-32	3
Craggy Dome Upper (B-CDU)	14-16	10
	>17	100+

Water was not encountered during drilling in any of the borings: however, fluctuations in the groundwater level due to seasonal and climatic effects should be expected.

Non-destructive testing by falling weight deflectometer (FWD) was conducted by ERES Consultants to assess pavement and subgrade structural conditions within the project limits. The FWD tests were performed in accordance with AASHTO T 256-77 (1990) and the *Guide of Design of Pavement Structures*. FWD testing involves subjecting a pavement to an impulse load and measuring the resulting deflection basin.

The FWD had a seat load of 9 kips and two test loads of 12 and 15 kips. The shape and magnitude of the deflection basin are used to analytically determine the moduli of the pavement and subgrade using software packages such as EverCalc or WESDEF. These properties are in turn used to determine the structural support capability of the pavement using a pavement design method such as the AASHTO method. The properties can then be used to analytically estimate the pavement load capacity and remaining life of the pavement using a limiting stress/strain analysis. There were 138 non-destructive test locations on the parkway. Some data points were not useable due to subgrade conditions or interference from traffic; these data were discarded. The FWD report is provided in Appendix F.

Laboratory Testing

For classification, index properties, and design parameters, the following laboratory testing was conducted on select representative soil samples:

Atterberg limits (AASHTO T-89 and T-90)
Moisture content (AASHTO, T-265)
Sieve analysis (AASHTO T-88)

The results of the laboratory soil tests are presented in Appendix G and summarized in Table 3.

TABLE 3
Summary of Laboratory Tests Results

Mile, Station (Boring No.)	Sample Number	Water Content (%)	Atterberg Limits			Percent Passing No. 200 Sieve	AASHTO Classifi-cation
			LL	PL	PI		
359 41+50 (B-1)	1	28.8	46	31	15	50.4	A-7-6
	2	21.6	33	27	6	34.9	A-2-4
360 50+00 (B-2)	1	67.9	65			61.5	A-7-6
	2	15.8	32			29.3	A-2-4
361 51+00 (B-3)	1	10.7				26.7	A-2-4
362 10+50 (B-4)	1	4.5					A-2-4
362 23+00 (B-5)	1	26				37.7	A-4
	2	32.9					A-4
362 51+00 (B-6)	1	7.3					A-2-4
	2	9.7					A-2-4

TABLE 3 (cont.) Summary of Laboratory Tests Results							
Mile, Station (Boring No.)	Sample Number	Water Content (%)	Atterberg Limits			Percent Passing No. 200 Sieve	AASHTO Classification
			LL	PL	PI		
363 10+50 (B-7)	1	11.1	33			28.1	A-2-4
	2	11.8					A-2-4
363 34+00 (B-8)	1	17.8				24.4	A-2-4
	2	10.4					A-2-4
364 3+50 (B-9)	1	2.8					A-2-4
364 36+00 (B-10)	1	11.1					A-2-4
	2	5					A-2-4
365 11+00 (B-11)	1	22.2				32.3	A-2-4
	2	10.3					A-2-4
366 11+00 (B-12)	1	14.6					A-2-4
	2	12.8	34			24.1	A-2-4
366 15+00 (B-13)	1	9.1					A-2-4
366 43+00 (B-14)	1	5.5					A-2-4
	2	4.2					A-2-4
367 39+00 (B-16)	1	11.1					A-2-4
	2	9.9					A-2-4
368 12+50 (B-17)	1	19.9				34.9	A-2-4
	2	20.6					A-2-4
368 38+00 (B-18)	1	15.2	41			31.3	A-2-4
369 4+50 (B-19)	1	12.2					A-2-4
	2	4.7					A-2-4
369 14+00 (B-20)	1	9.9					A-2-4
	2	9.6					A-2-4
369 39+00 (B-21)	1	5.5					A-2-4
370 13+00 (B-22)	1	10.3					A-2-4
	2	8.0	32			21.7	A-2-4
370 38+00 (B-23)	1	9.7				31.2	A-2-4
	2	7.2					A-2-4
371 15+00 (B-24)	1	11.3				23.1	A-2-4
	2	14.9					A-2-4
371 25+00 (B-25)	1	10.9				27.2	A-2-4
	2	28.3				46.3	A-4

TABLE 3 (cont.) Summary of Laboratory Tests Results							
Mile, Station (Boring No.)	Sample Number	Water Content (%)	Atterberg Limits			Percent Passing No. 200 Sieve	AASHTO Classifi-cation
			LL	PL	PI		
371 30+00 (B-26)	1	11.3				22.7	A-2-4
	2	6.7					A-2-4
372 14+00 (B-27)	1	17.9	25	24	1	37.8	A-4
372 39+50 (B-28)	1	12.6				17.7	A-2-4
	2	18				32.6	A-2-4
373 17+00 (B-29)	1	13.4				32.1	A-2-4
373 37+00 (B-30)	1	19.3				50.4	A-4
	2	21.2				40.6	A-4
373 49+50 (B-31)	1	16.6	33	31	2	39.6	A-4
	2	7.					A-2-4
374 36+00 (B-32)	1	19.7	34			40.3	A-4
	2	3.1					A-2-4
375 0+00 (B-33)	1	14.2	29	24	5	48.2	A-4
	2	0.9					A-2-4
PA 20+50 (B-34)	1	7.9					A-2-4
	2	20					A-2-4
PA 36+80 (B-35)	1	27.4				33.2	A-2-4
	2	27.8					A-2-4
Picnic Parking (B-PA)	1	8.7				23.2	A-2-4
	2	4.9					A-2-4
Visitor Center (B-VC)	1	20.5				28.2	A-2-4
	2	29.4					A-2-4
Craggy Dome Lower (B-CDL)	1	33.1				36.8	A-2-4
Craggy Dome Upper (B-CDU)	1	10					A-2-4
	2	0.8					A-2-4

Tests were conducted on eight asphalt cores that were drilled during the field investigation. The thicknesses of the cores were measured. The in-place density and absorption were then determined, which indicates the asphalts compaction and in-place air voids. The asphalt cores were combined in order to have enough sample to evaluate the in-place hot-mix asphalt characteristics. These tests included determining the asphalt content, aggregate gradation, and the absolute viscosity of the recovered asphalt surface course and binder. The cores were grouped into three representative composite (Group 1, 2, and 3) samples. Tests were conducted to determine the asphalt content and aggregate gradation (T-30) of the hot-mix-asphalt mixture and the absolute viscosity of the recovered asphalt binder. The results of the laboratory asphalt tests are presented in Appendix G and summarized in tables 4, 5, and 6.

TABLE 4

Asphalt Pavement Properties

Core No.	Mile, Station	Layer	Thickness (in)	Bulk Specific Gravity	Absorption (%)
1	360 24+00	Surface	1	Damaged	Damaged
		Binder	1.5	2.304	0.98
		Base	2	2.397	0.36
2	361 51+00	Surface	1.2	2.299	0.36
		Binder	3	2.313	2.58
		Base	2.7	2.407	0.91
3	365 11+00	Surface	1.5	2.253	1.67
		Base	2.3	2.272	3.09
4	367 39+00	Surface	1.1	2.182	1.87
		Base	2.1	2.291	3.7
5	369 39+00	Surface	1	2.245	1.59
		Binder	1.6	2.32	2.03
		Base	1.4	2.377	0.5
6	372 14+00	Surface	1.1	2.212	1.95
		Base	2.2	2.304	1.36
7	373 37+00	Surface	1.4	2.196	4.22
		Base	2	2.342	1.07
8	374 36+00	Surface	1.3	2.148	4.08
		Base	2.3	2.346	2.93

TABLE 5

Hot Mix Asphalt Properties
Surface Course Layer

Sieve Size	Percent Passing		
	Group 1	Group 2	Group 3
1/2 in.	100.0	100.0	100.0
3/8 in.	95.2	91.9	95.3
No. 4	63.9	50.3	53.5
No. 8	48.1	23.2	23.5
No. 16	37.7	14.6	13.3
No. 30	29.1	11.9	10.4
No. 50	20.0	9.8	8.4
No. 200	5.8	4.7	3.8
Asphalt Content (%)	5.9	5.6	5.5
Absolute Viscosity (poise)	37,612	198,644	319,342

Note: Composite Samples - Cores trimmed and combined

Group 1 = Cores 1 and 2
Group 2 = Cores 3, 4, and 5
Group 3 = Cores 6, 7, and 8

TABLE 6

Hot Mix Asphalt Properties
Binder/Base Course Layer

Sieve Size	Percent Passing		
	Group 1	Group 2	Group 3
1 in.	100.0	100.0	100.0
3/4 in.	97.6	97.8	99.5
1/2 in.	78.6	86.1	83.6
3/8 in.	66.6	72.4	71.9
No. 4	45.4	51.7	54.5
No. 8	36.4	36.7	42.8
No. 16	30.1	28.0	33.4
No. 30	23.9	21.5	25.3

TABLE 6 (cont.) Hot Mix Asphalt Properties Binder/Base Course Layer			
	Percent Passing		
Sieve Size	Group 1	Group 2	Group 3
No. 50	16.3	14.2	16.5
No. 200	4.7	5.3	6.2
Asphalt Content (%)	5.1	4.9	5.0
Absolute Viscosity (poise)	32,516	283,912	215,887
Note: Composite Samples - Cores trimmed and combined Group 1 = Cores 1 and 2 Group 2 = Cores 3, 4, and 5 Group 3 = Cores 6, 7, and 8			

Data Summary

The boring logs represent a compilation of field and laboratory data and descriptions of the soil samples by a geotechnical engineer. As shown on the geologic map included as Figure 13, Section 2P is located on two different geologic groups within the Ashe Metamorphic Suite. The first geologic group runs from Milepost 359.8 to just west of Milepost 370.0. This group consists of Kyanite schist and gneiss. The second part of the project from just west of Milepost 370.0 to Milepost 375.3 is located in the Muscovite-Biotite gneiss group. From the subsurface investigation and the laboratory results, no noticeable differences in soil classification are detected among the various geologic units.

The soils throughout the project are generally classified as silty sands (SM) with a significant percent of fines (silt size) and rock fragments with an AASHTO classification of A-2-4. Moisture content was taken from each sample recovered and typically ranged from 10 to 20 percent. Atterberg limits were attempted on a few samples with results showing a low plasticity index (PI). Sieve analyses were conducted on 36 samples to determine the percent passing the No. 200 sieve. The results ranged from 17.7 to 61.5 percent, typically between 22 and 45 percent.

Pavement Design

The project was analyzed by stations and separated into segments. These segments were determined by the pavement condition survey, field date (DCP), laboratory data, and the non-destructive testing. All previously mentioned information was collected, summarized, and compiled to determine the final design.

Flexible pavement design and new asphaltic concrete pavement design analyses are performed in accordance with AASHTO *Guide for Design of Pavement Structures*, 1993. The flexible pavement design analyses are for a 20-year performance period. The design analysis to determine the 18-kip equivalent single axle load (ESAL) for the roadway is based upon average daily traffic (ADT) counts for the highway section. The traffic on the non-highway sections (pullouts, visitor center parking, picnic road, etc) should be considerably less than the main highway. For the non-highway pavements, the ADT was reduced by half. The traffic counts are assumed to include 2.5 percent recreational vehicles, 2.5 percent travel trailers, and 0.2 percent construction/ maintenance vehicles. A traffic growth rate of 2 percent is also assumed. The effective roadbed soil support number is determined for each section of roadway from empirical correlation to CBR values and soil classifications. Other parameters specified in the analysis include a 50 percent directional factor, a lane distribution factor of 1.0, a regional factor of 1.5, and a terminal serviceability index of 2.0. A design structural number is calculated using the parameters above and compared against the structural number calculated from the thickness and structural coefficient of each layer. In the design for the mill and overlay sections, the underlying base material was given a conservative structural coefficient of 0.11, which correlates to a CBR of 50. The asphalt left after milling was given a reduced structural coefficient of 0.2.

The nominal maximum size aggregate (NMSA) was supplied for each asphalt layer by the FHWA. The NMSA for the AC binder layer is 0.75 inch and 0.5 inch for the AC surface course. The NMSA is important because each asphalt layer must be three to four times the thickness of the aggregate. Therefore, minimum thicknesses of 1.5 inches for surface layer and 2.5 inches for binder layer are recommended.

The reconstruction typical sections were determined to have two different designs. One of the designs is for the mainline parkway and other one is for the Craggy Dome upper parking, Craggy Garden picnic parking, and Visitor Center parking. The following section is for the mainline parkway. The pavement design consists of compacting an existing 6 inches of base overlain by 3 inches of AC binder topped with 2 inches of AC surface course. The other reconstruction design also includes compaction of existing base with 2.5 inches of AC binder and 1.5 inches of surface course. The typical pavement and repair sections are provided in tables 7 and 8.

TABLE 7

Typical Sections for Repair

Typical Section No.	Reconstruction
1	2.0" Surface Course, Class C, Grade D, Type III Smoothness
	3.0" Binder, Grade C
	6.0" Recompacted Existing Base
2	1.5" Surface Course, Class C, Grade D, Type III Smoothness
	2.5" Binder, Grade C
	6.0" Recompacted Existing Base
Option	**Milling and Overlay**
3	Mill 2.0"
	Replace with 2.5" Binder, Grade C
	1.5" Surface Course, Class C, Grading D, Type III Smoothness
4	Mill 1.0"
	Replace with 2.5" Binder, Grade C
	1.5" Surface Course, Class C, Grade D, Type III Smoothness

TABLE 8

Recommended Sections and Repairs

	Beginning Mile, Station	Ending Mile, Station	Repair Method	Typical Section No. (from Table 7)
Parkway	359, 39+00	366, 24+10	Mill & Overlay	3
	366, 24+10	368, 20+00	Reconstruction	1
	368, 20+00	370, 2+00	Mill & Overlay	3
	370, 2+00	375, 4+57	Reconstruction	1
Craggy Garden	Access Road		Both	1 and 3
	Picnic Parking		Reconstruction	2
Craggy Dome	2-Tier Parking		Reconstruction	2

TABLE 8 (cont.) Recommended Sections and Repairs				
	Beginning Mile, Station	**Ending Mile, Station**	**Repair Method**	**Typical Section No. (from Table 7)**
Visitor Center	Parking		Reconstruction	2
Overlooks	Balsam Gap		Mill & Overlay	4
	Bull Creek		Mill & Overlay	4
	Graybeard		Mill & Overlay	4
	Glassmine Falls		Mill & Overlay	4
	Lane Pinnacle		Mill & Overlay	4

Less-distressed segments can be repaired by milling and overlaying. Such areas may be milled 1 to 2 inches and overlaid with 2.5 inches of binder and 1.5 inches of AC surface course. During the milling process, a minimum of 1.5 inches of asphalt should be left on the roadway. The sections from approximately Milepost 367 to 375.3 typically have pavement thickness ranging from 3 to 4 inches. The pavement design calculations are located in Appendix H.

Supplemental Investigation

Since the 70 percent submittal, additional investigation has been conducted along the parkway. This investigation was conducted to confirm the existence and define the nature of any base type material immediately underlying the existing pavements. The NPS requires that the mainline pavement remain open to traffic during reconstruction and that reconstructed sections are covered with a binder layer at the end of each day. Therefore, it is significant that any existing base section be utilized versus requiring a new base section and lengthening the construction process. A total of 13 asphalt sections from mile marker 368.0 to 375.0 were cored and measured and samples of the underlying base material were collected. Representative samples of the base material were transported to the laboratory for sieve analyses. The results are summarized below in Table 9. The test results are located in Appendix G. Photographs of the cores are included in Appendix B.

TABLE 9

Laboratory Test Results for Existing Base Material

Milepost	Sieve Size	% Passing	Milepost	Sieve Size	% Passing
370.0	¾"	74.3	374.0	¾"	70.1
	#4	44.8		#4	39.8
	#10	38.0		#10	34.4
	#40	27.1		#40	24.2
	#200	13.0		#200	11.3
373.0	¾"	77.1	374.3	¾"	76.9
	#4	52.7		#4	46.5
	#10	46.0		#10	41.1
	#40	32.0		#40	30.7
	#200	11.9		#200	14.3
373.5	¾"	74.2	375.0	¾"	90.2
	#4	41.1		#4	55.0
	#10	35.8		#10	46.5
	#40	25.3		#40	32.4
	#200	11.2		#200	14.3

Investigation of the three areas of instability at mileposts 361.8, 362.8, and 363.4 were determined not to be deep-rooted stability problems. The pavement depressions at these three areas appear due to the loss of finer subgrade material into the underlying boulder fill. The boulder fill has large open voids into which the subgrade soils have migrated over the years. A deep subgrade patch will be required for this repair. These three areas defined on the plans should be sub-excavated an additional 6 inches beyond the normal repair. Geotextile Type III-B per section 704 of the FP-96 specifications should be placed on the sub-excavated areas and the area backfilled with compacted aggregate base.

Recommendations

Our recommendations, based on the findings of our subsurface investigation of the Blue Ridge Parkway Rehabilitation project area, are as follows:

Earthwork

Aggregate Base Course

Design of the pavement sections has considered the existing base material. Once the asphalt pavement has been removed the base material should be compacted to 95 percent of a modified proctor (AASHTO T-180). Areas showing rutting or pumping should be excavated and replaced for a minimum thickness of 6 inches.

Pavement Section

Due to the inconsistent distresses, various repairs are required. Areas requiring mill and overlay, exposed potholes, and shrinkage cracks greater than 0.10 inch in width should be repaired before placing overlay. The typical pavement repair sections are provided in Table 7 with the affected stations, parking areas, and overlooks listed in Table 8.

Craggy Dome Retaining Wall

At the Craggy Dome Overlook, located at Milepost 364.1, stone retaining walls are utilized to support both upper and lower parking lots. The retaining walls are constructed of dry stacked Grandfather Mountain Stones with the upper 2 feet of stones mortared together.

The lower retaining wall is approximately 255 feet in length and varies in height from approximately 4 to 13 feet. The upper retaining wall is approximately 116 feet in length and varies in height from 3 to 7 feet.

Both the upper and lower walls were visually examined and representative stones and cracks measured and photographed. Due to deterioration over the years, the upper wall has undergone differential settlement, both vertically and horizontally, causing tilting and separation of the stones.

The lower retaining wall was evaluated and found to be generally stable and will not need to be removed. The existing culvert through the wall in the northwest corner is plugged and a new culvert is to be rerouted from the existing inlet around the end of the wall.

The upper retaining wall will need to be partially dismantled and carefully rebuilt. Approximately 66 linear feet of wall will be dismantled and rebuilt. The inlet box and culvert appear to have had an effect on the walls stability. Complete replacement of the inlet and culvert along with the placement of a concrete foundation beneath the dismantled section will correct the wall deficiencies.

Once the stones are removed, a concrete footing will be built for support of the stones. The stone walls will then be rebuilt, following the stone layout and numbering scheme to replicate the original wall.

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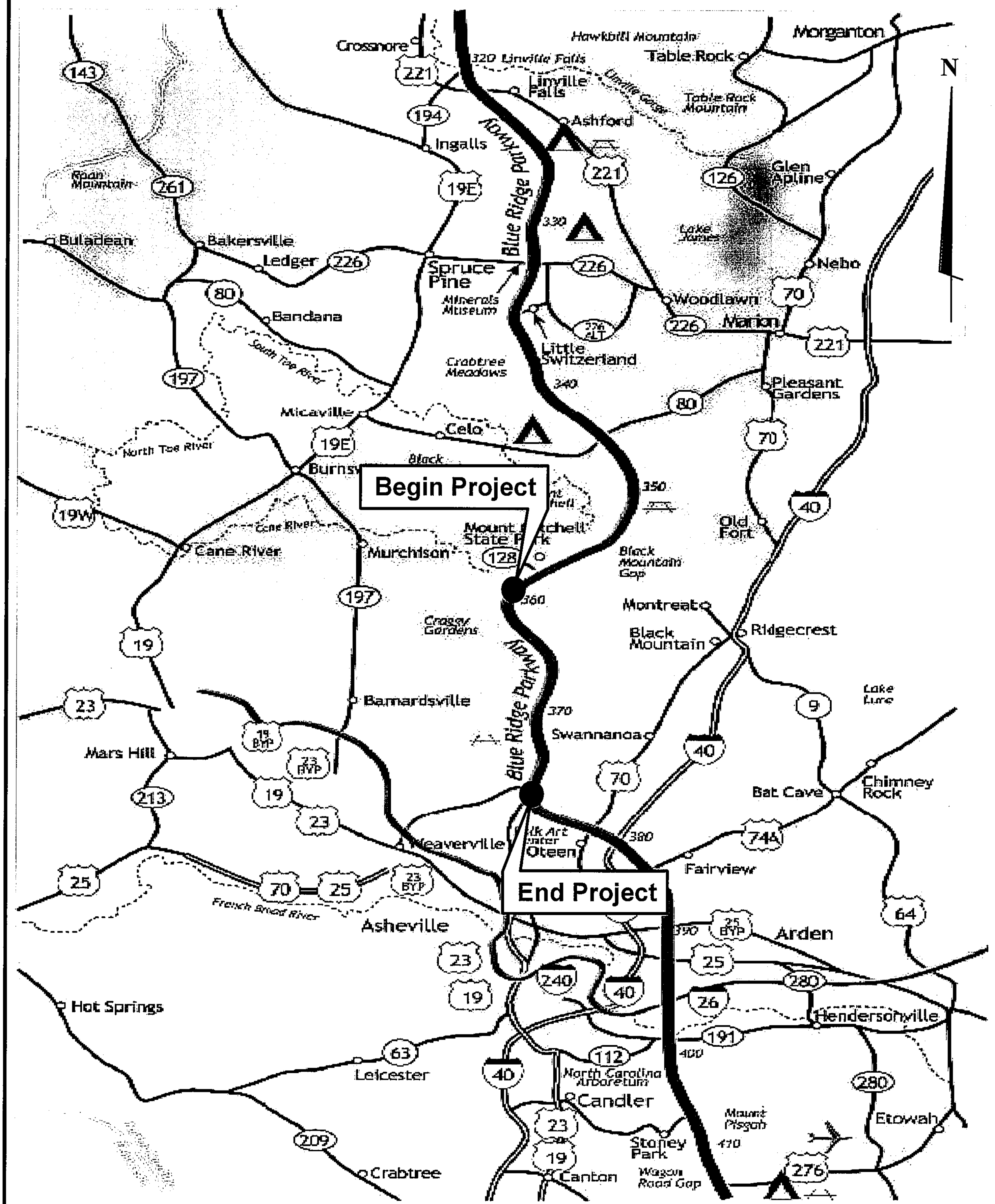
6. AASHTO, *AASHTO Guide for Design of Pavement Structures,* Washington, D.C., 1993.

7. AASHTO, *AASHTO Interim Guide for Design of Pavement Structures,* Washington, D.C., 1981.

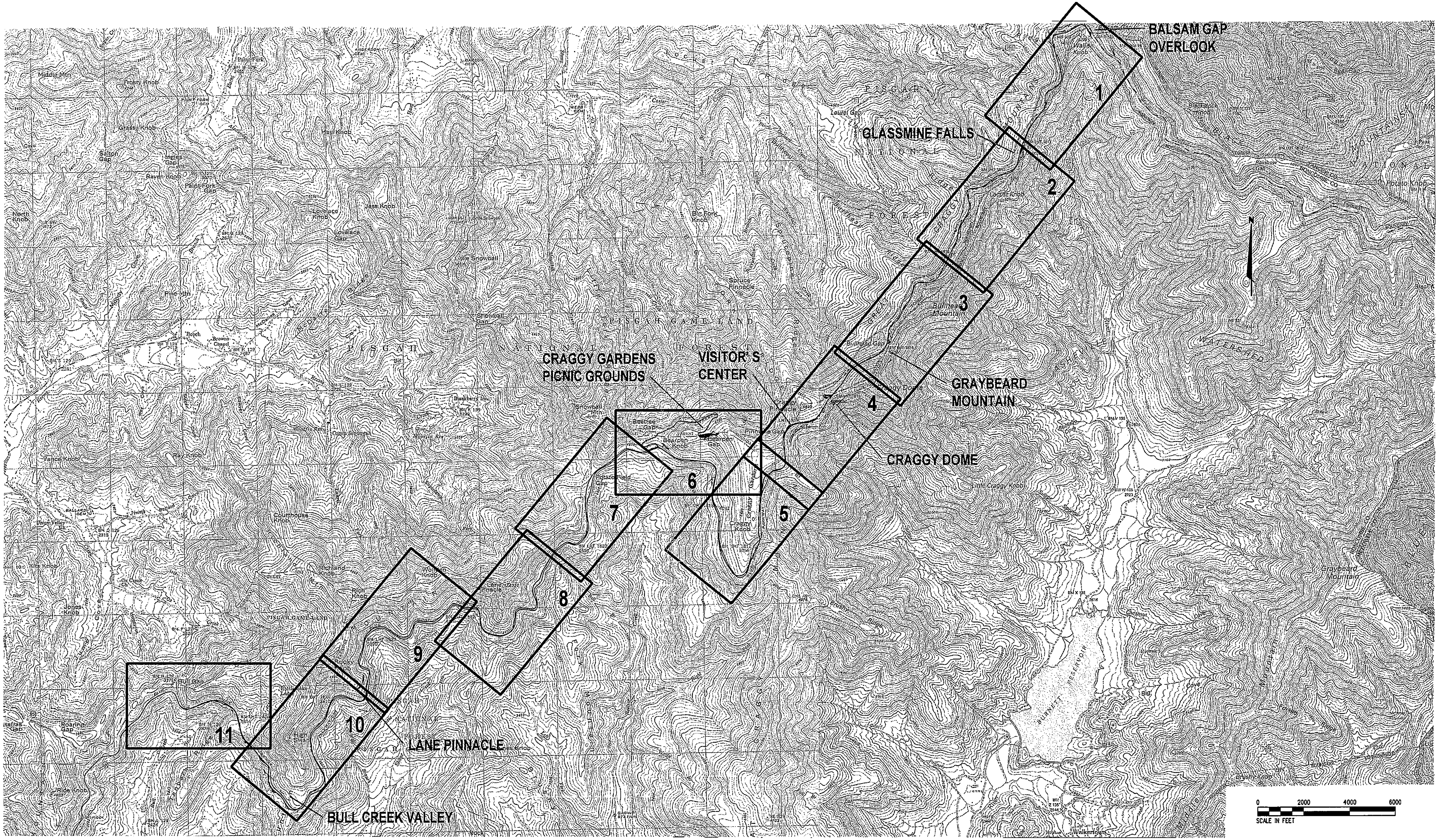
8. Federal Highway Administration, *Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, FP-96 English Units*, Washington, D.C., 2001.

Appendix A

Project Maps



ARCADIS 1210 PREMIER DRIVE, SUITE 200 CHATTANOOGA, TN 37421 Tel. 423/756-7193 Fax 423/756-7197	**LOCATION MAP** **BLUE RIDGE PARKWAY** **YANCEY & BUNCOMBE COUNTIES, NC**	PROJECT NUMBER CT052885 FIGURE NUMBER 1



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PROJECT NUMBER: CT052885	DRAWING NUMBER: FIGURE 2
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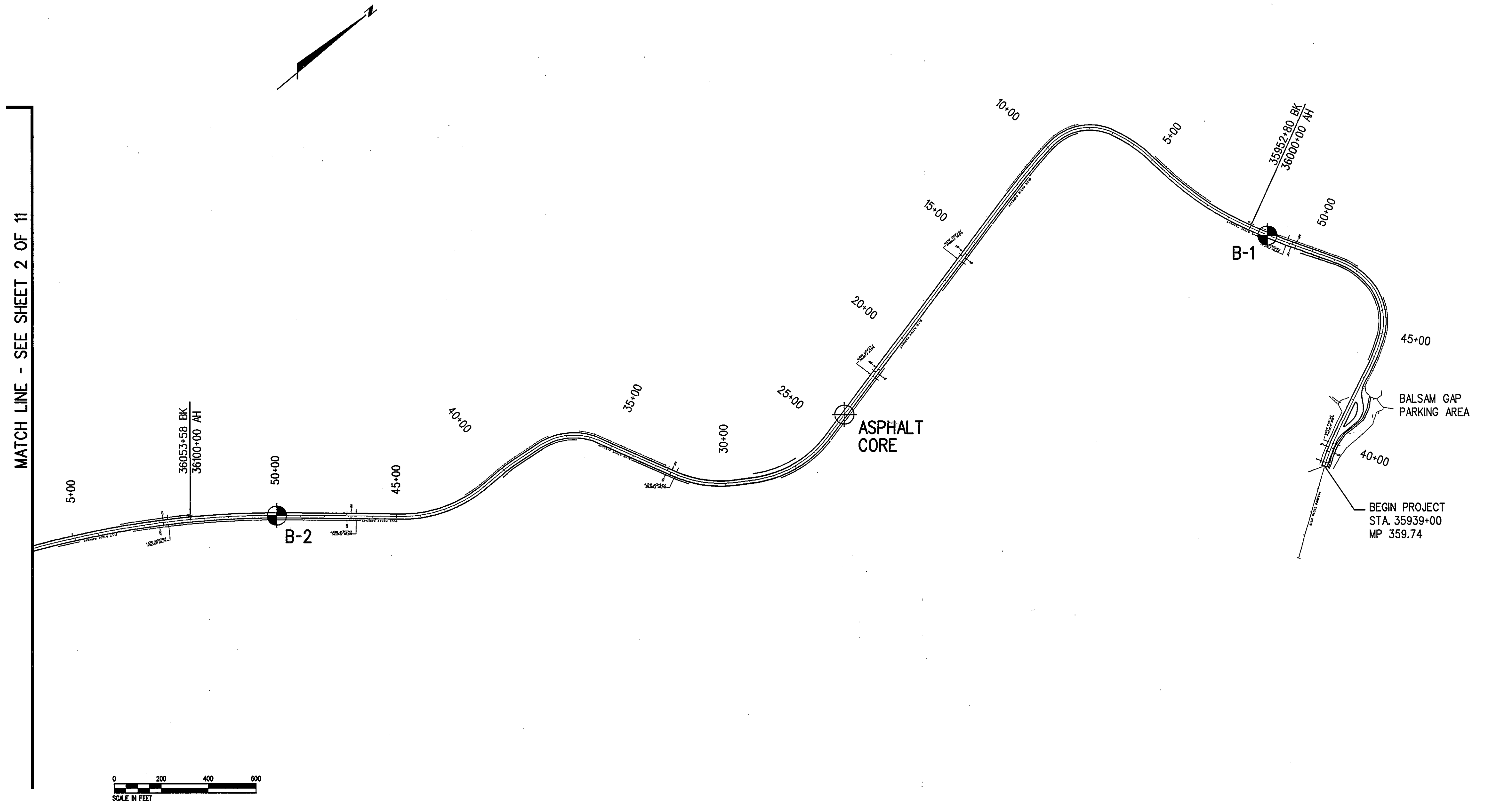

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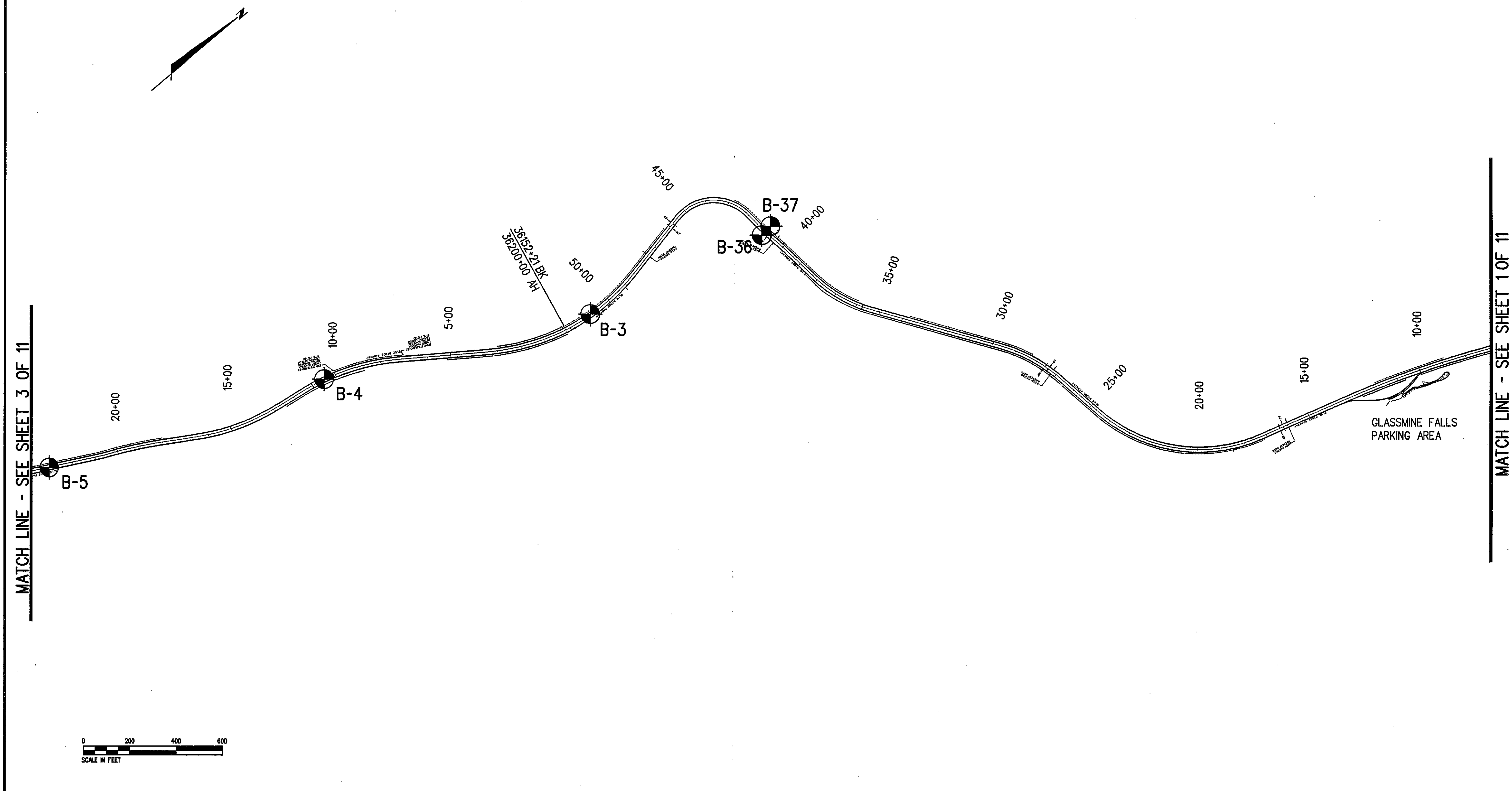
BORING LOCATION PLAN
SHEET 1 OF 11



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		SCALE AS SHOWN	CHECKED S. MANNING
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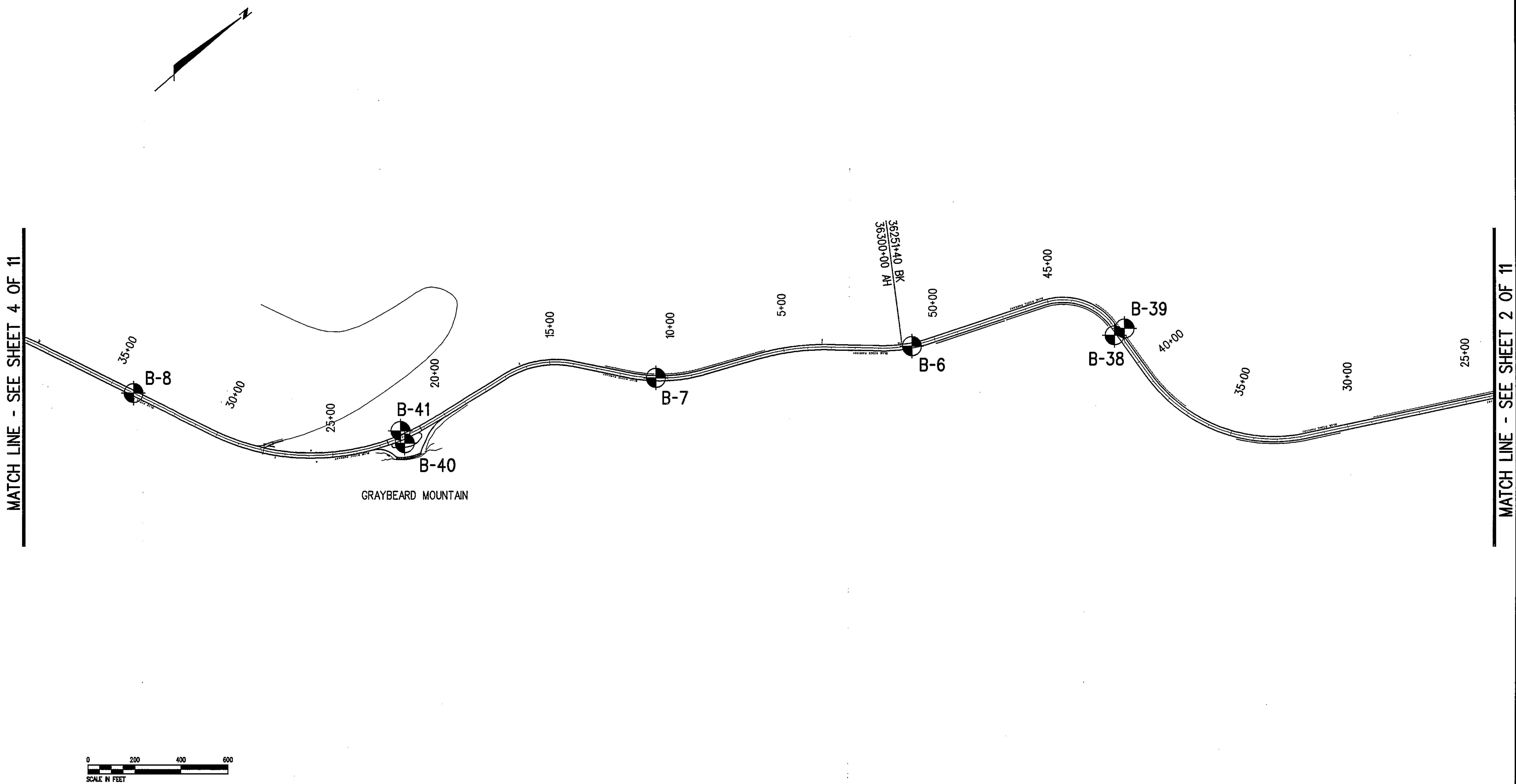

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BORING LOCATION PLAN SHEET 3 OF 11		SCALE AS SHOWN	CHECKED S. MANNING
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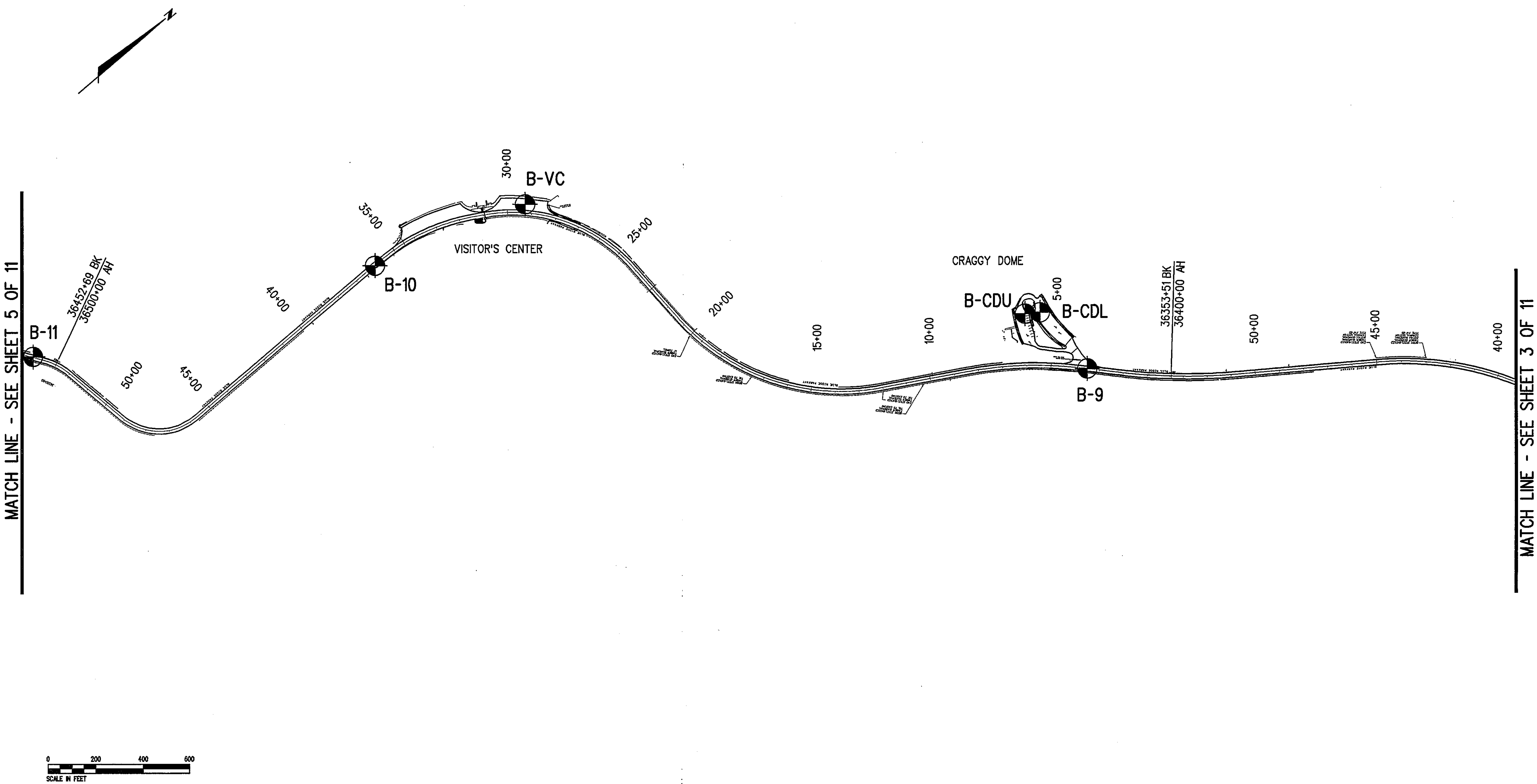

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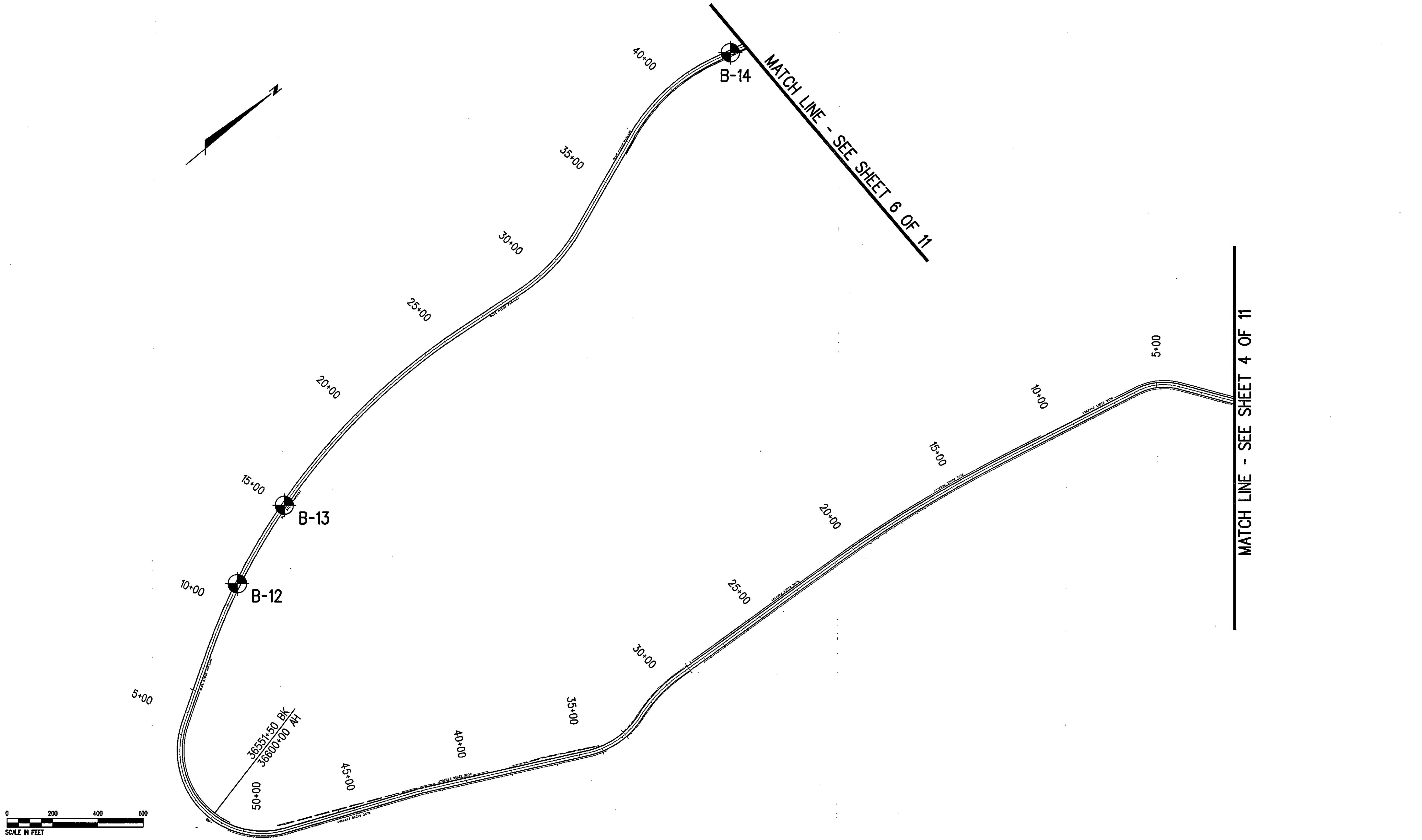

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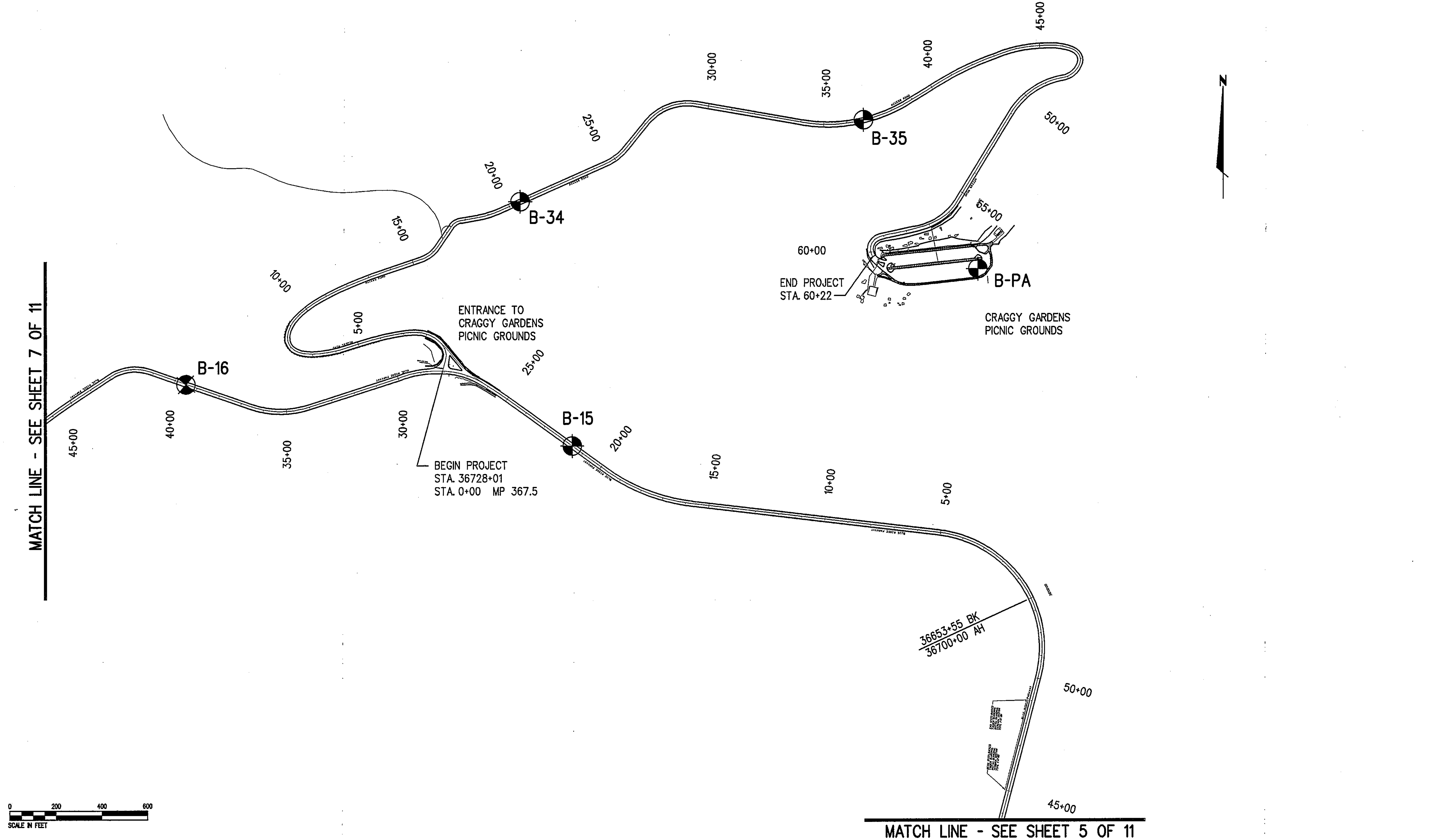

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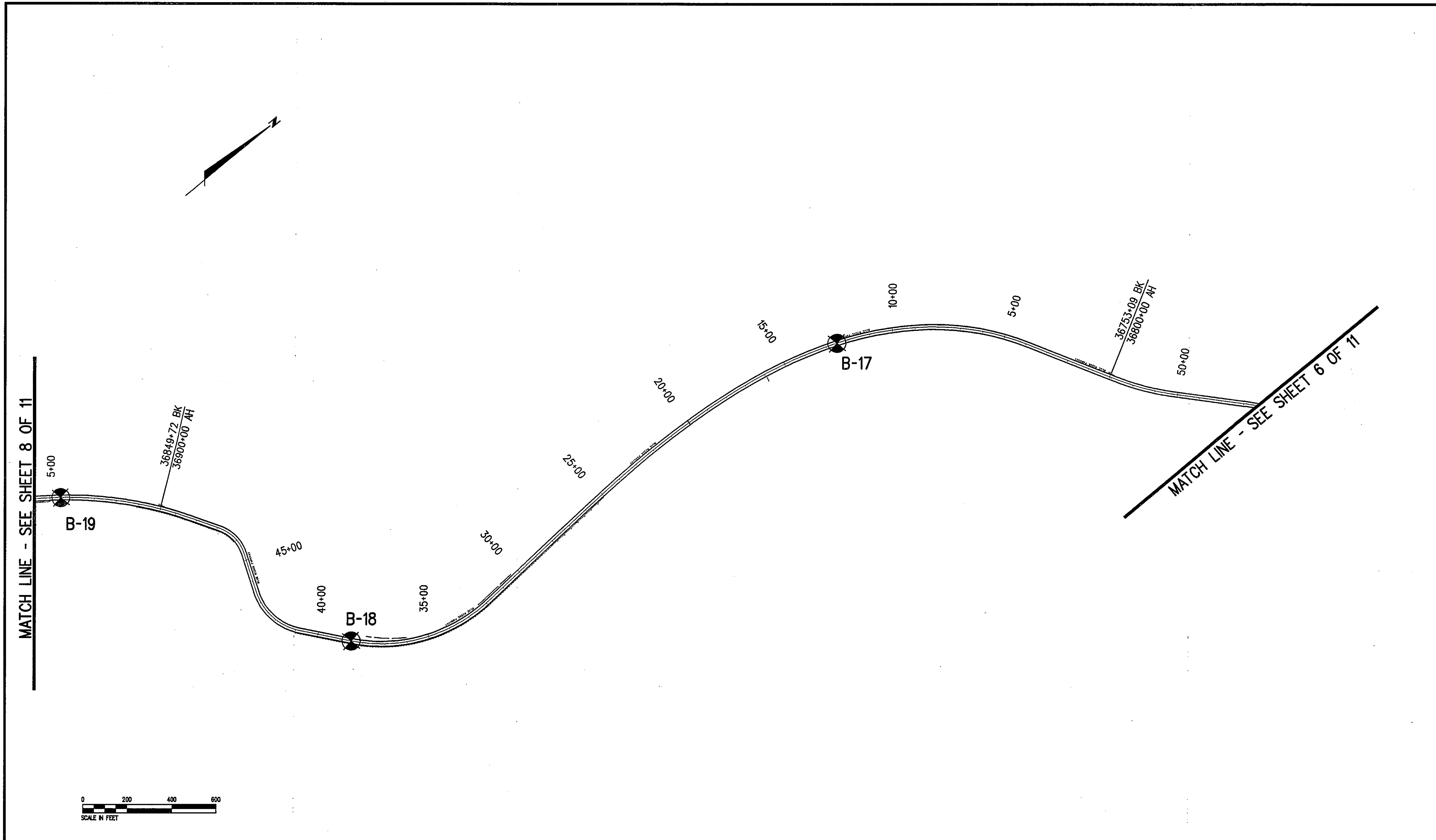

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BORING LOCATION PLAN
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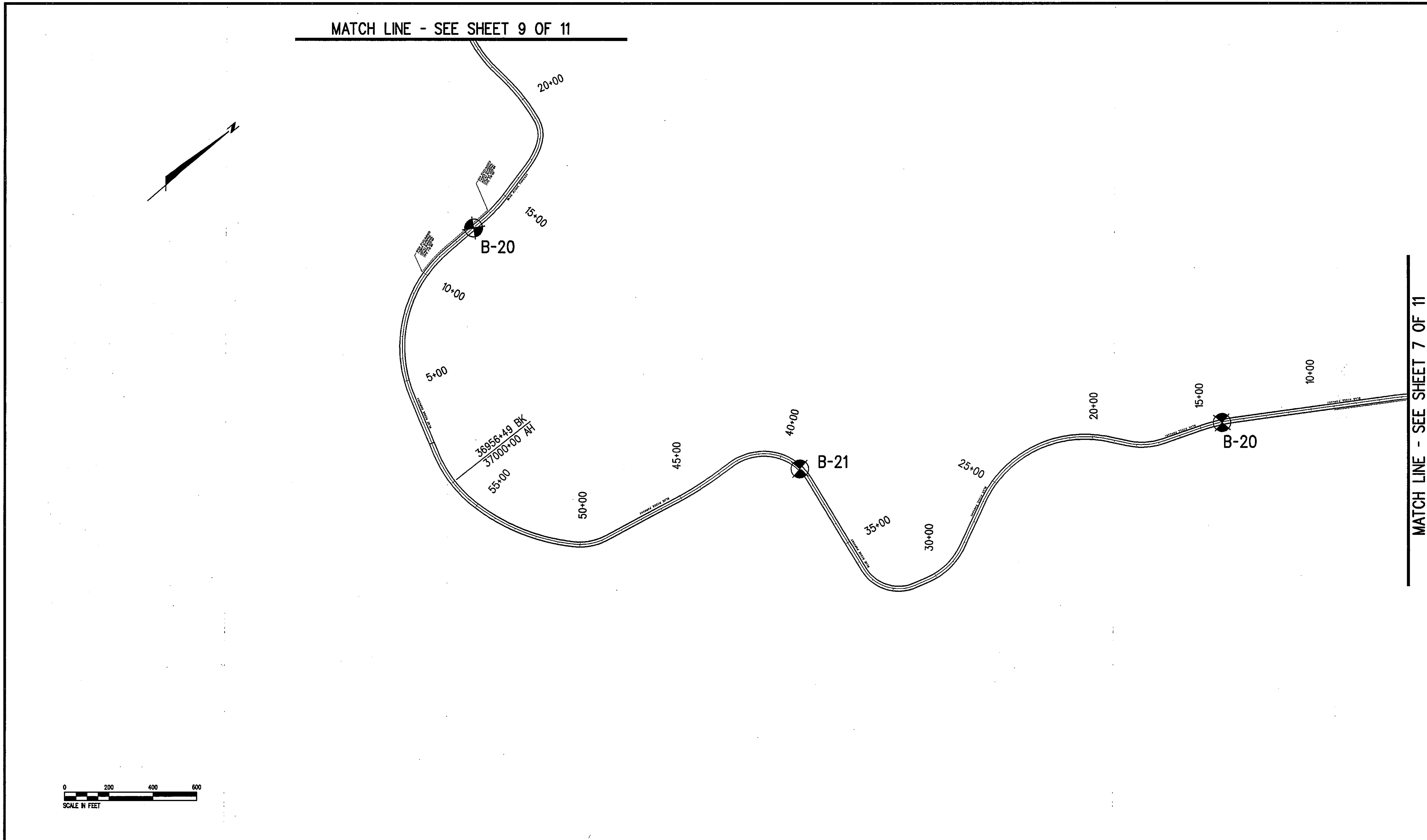

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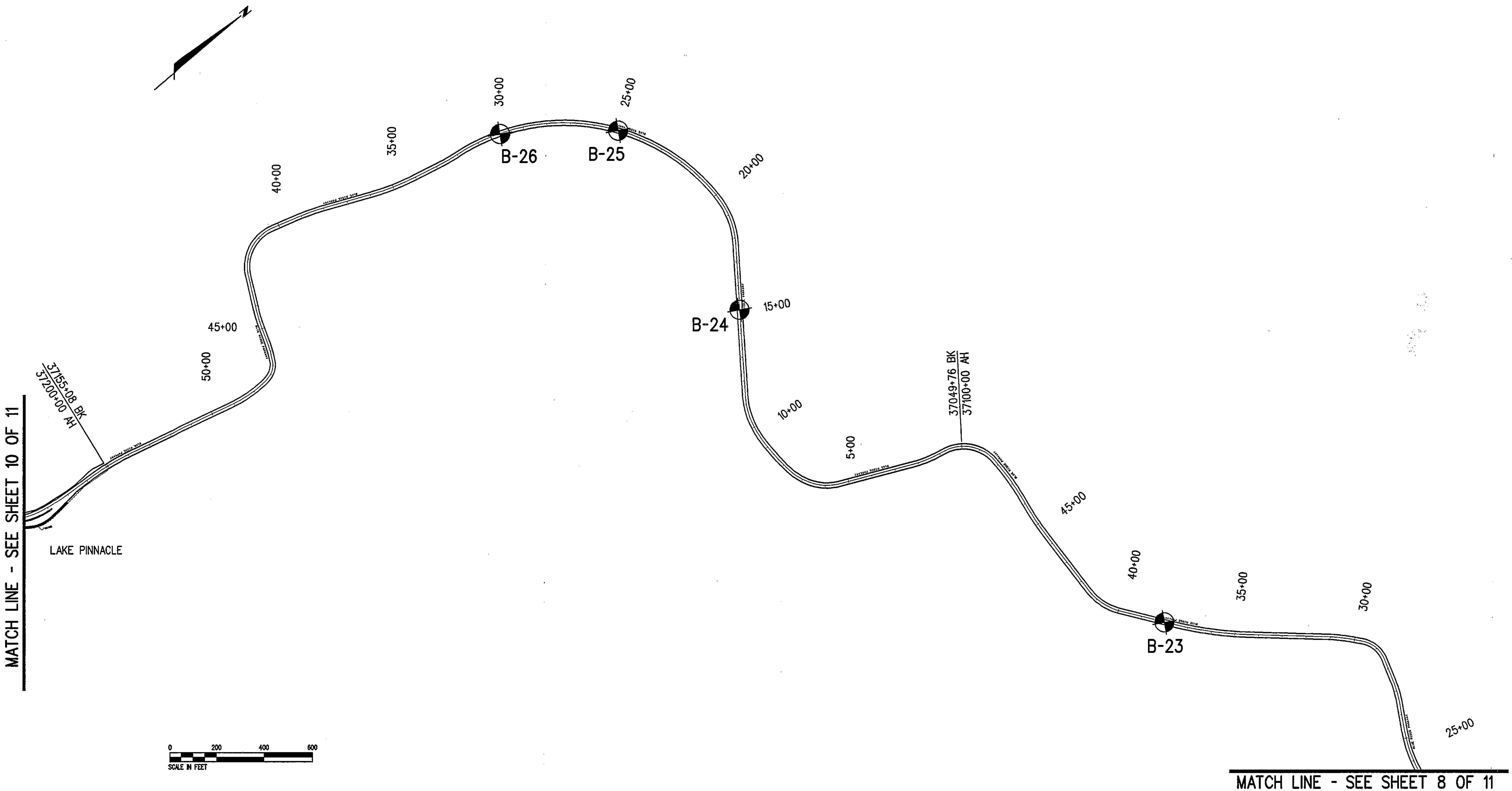

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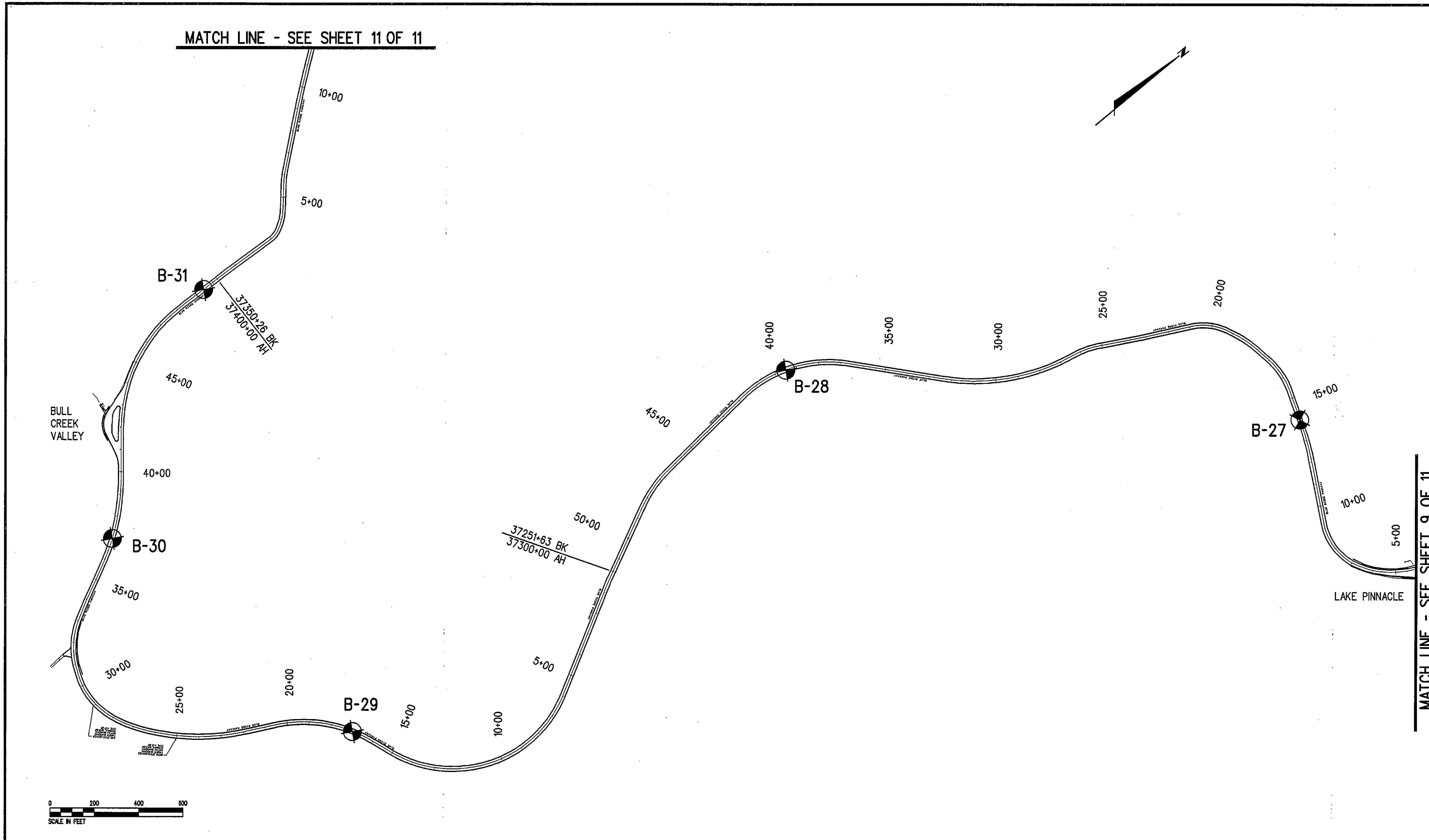

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SHEET 10 OF 11

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DEPARTMENT MANAGER	B. WHITAKER
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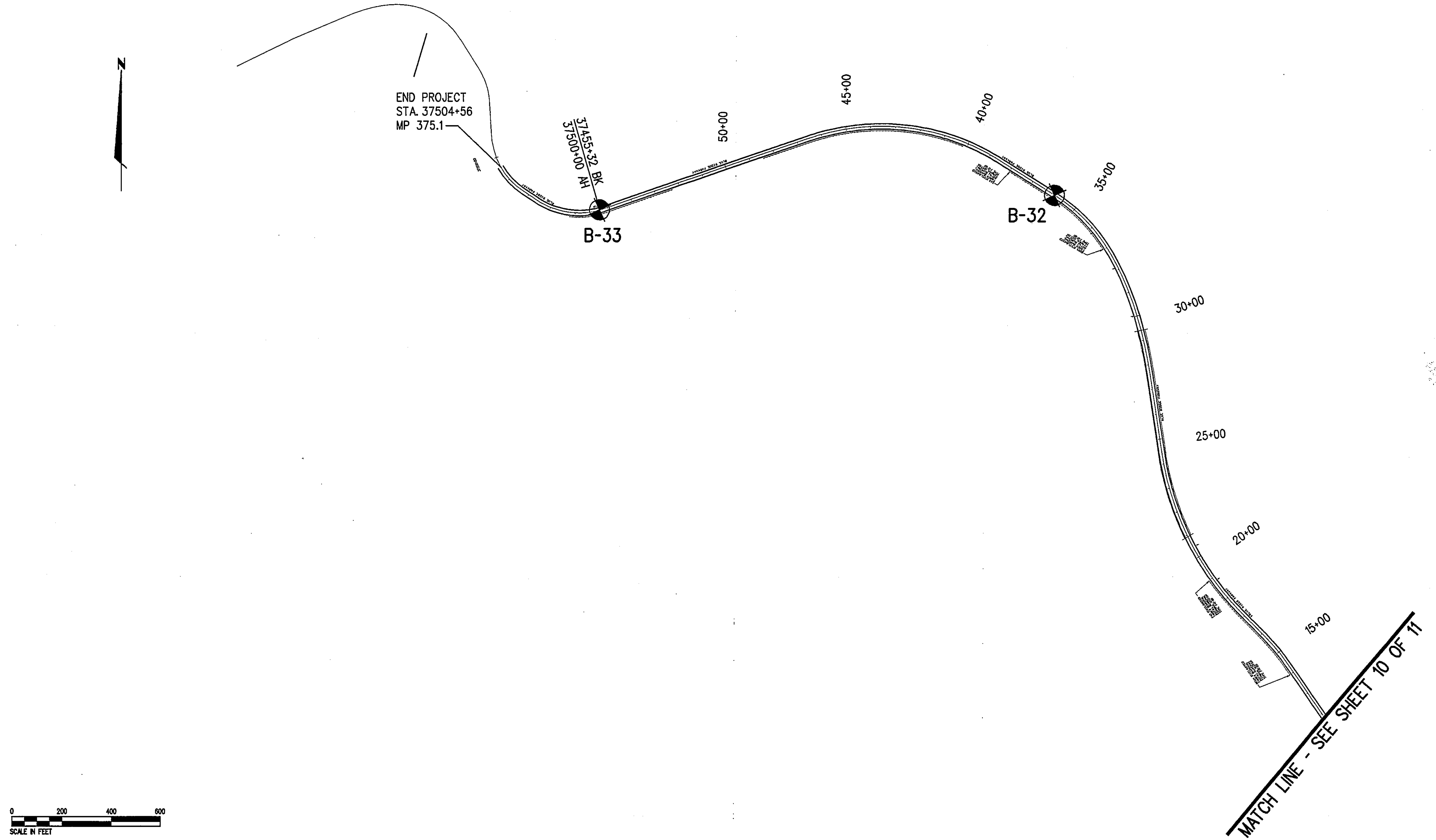

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BORING LOCATION PLAN
SHEET 11 OF 11

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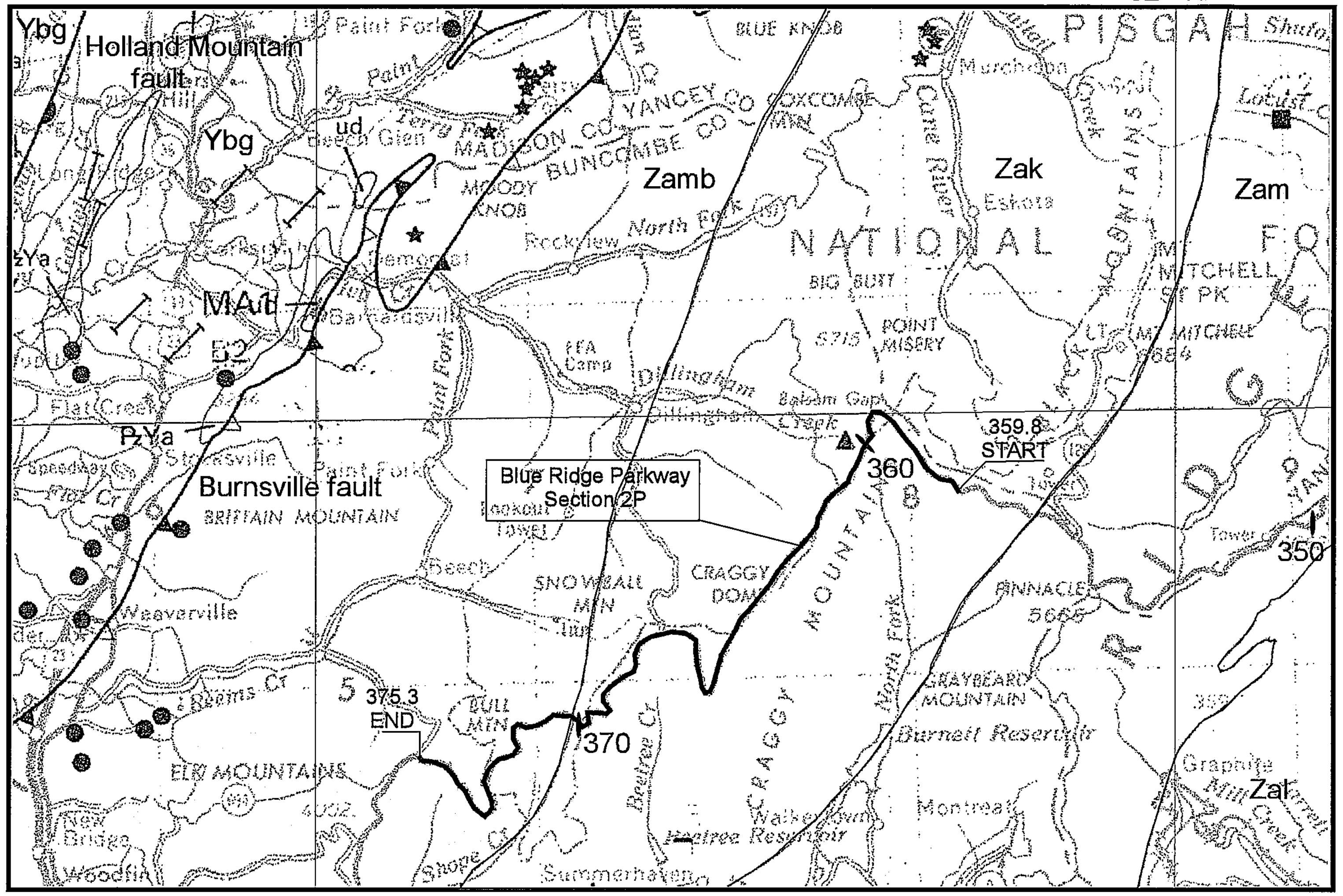

5 0 5 Miles

Modified from "Preliminary Bedrock Geologic Map of the Knoxville 1° x 2° Quadrangle, Tennessee, North Carolina, and South Carolina" by Robinson, G. R., Jr.; Lesure, F. J.; Marlowe, J. I. II; Foley, N. K.; and Clark, S. H., 1979.

MAP SYMBOLS

Burnsville fault - Now interpreted as strike-slip fault (Stewart, *et al.*, 1997).

Holland Mountain fault, semicircle points to up thrust sheet.

Lithologic contact

350 Mile markers, approximate location.

Project extent.

Description of Map Units

Unconformity

Ybg	Biotite gneiss - Pinkish gray to light gray, massive to well foliated, granitic to quartz monzonite; includes variably mylonitized orthogneiss and paragneiss interlayered amphibolite, calcsilicate rock, and marble.

Ashe Metamorphic Suite

Zal	Laminated biotite gneiss - Finely laminated to thin layered; locally contains massive gneiss and micaceous granule conglomerate; includes schist, phyllite, and amphibole.
Zam	Metagraywacke - Foliated to massive, locally conglomeratic; interlayered and gradational with mica schist, muscovite, muscovite- biotite gneiss, and rare graphite schist.
Zak	Kyanite schist and gneiss - Massive and interlayered with quartz schist and biotite gneiss. Garnet staurolite, and (or) sillimanite commonly occur; aluminous.
Zamb	Muscovite-biotite gneiss - Locally sulfidic; interlayered and gradational with mica schist, minor amphibolite and hornblend.

Richard Russell Formation and amphibolitic basement complex

PzYa	Amphibolite - Equigranular, massive to well foliated, interlayered, rarely discordant, metamorphosed intrusive and extrusive mafic rock; may include ultramafic rock and metasedimentary rock.

Intrusive and other igneous rocks

u ▲	Metaultramafic rock, undifferentiated - Metamorphosed dunite, serpintinite, soapstone, and other altered ultramafic rock. Smaller bodies shown by symbol.
ud ●	Dunite and peridotite - smaller bodies shown by symbol.
us ★	Talc schist, soapstone, and serpentinite - smaller bodies shown by symbol.

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BLUE RIDGE PARKWAY
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GEOLOGIC MAP

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		SCALE: AS SHOWN	CHECKED: S. MANNING
		PROJECT NUMBER: CT052885	FIGURE NUMBER: 14

Appendix B

Project Photographs

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Project Photos

Rehabilitation of
Blue Ridge Parkway

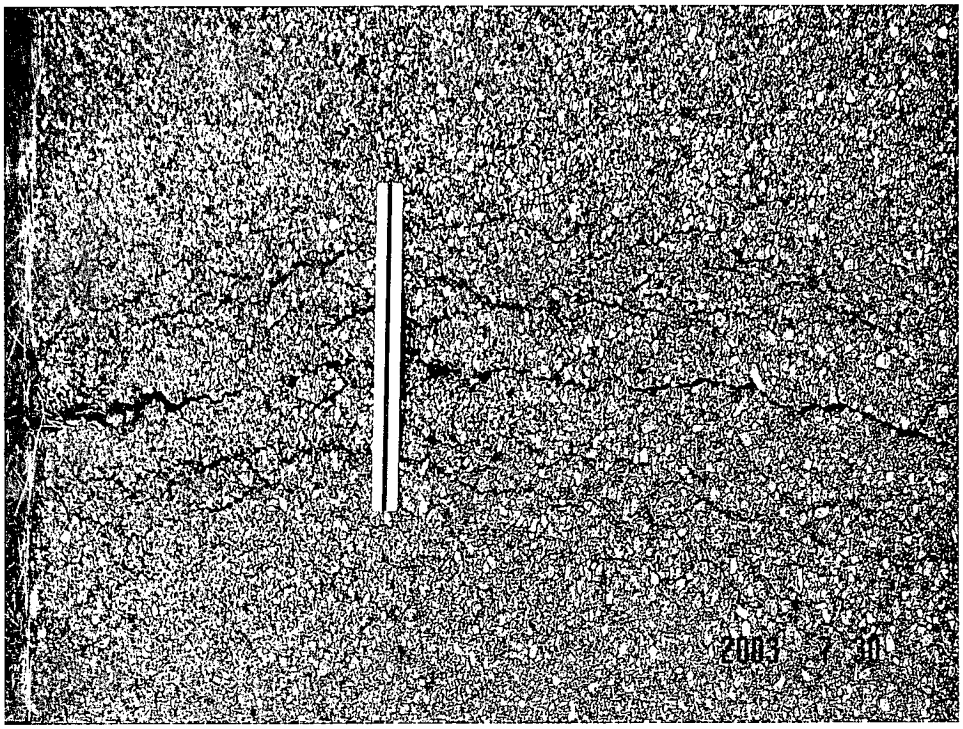


Photo 1

1/4-Inch Transverse Crack with Adjacent Fatigue Cracking

Photo 2

High Fatigue Cracking with High Severity Patching in Wheel Paths

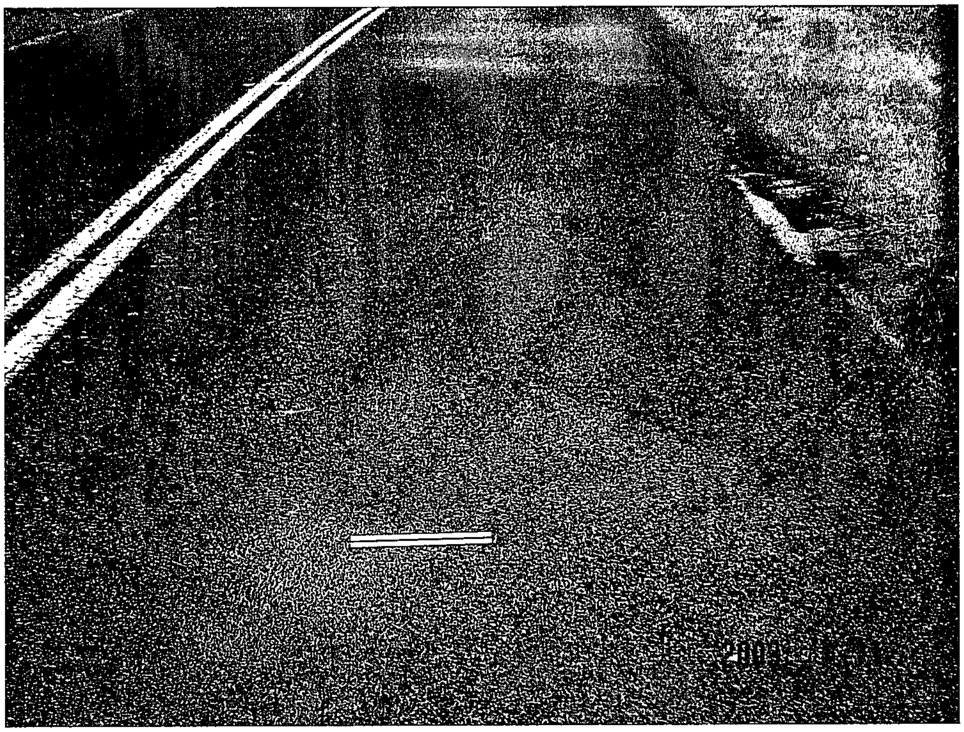


Photo 3
Moderate Severity Fatigue Cracking in Wheel Paths

Photo 4
Low Severity Fatigue Cracking in Wheel Paths

ARCADIS

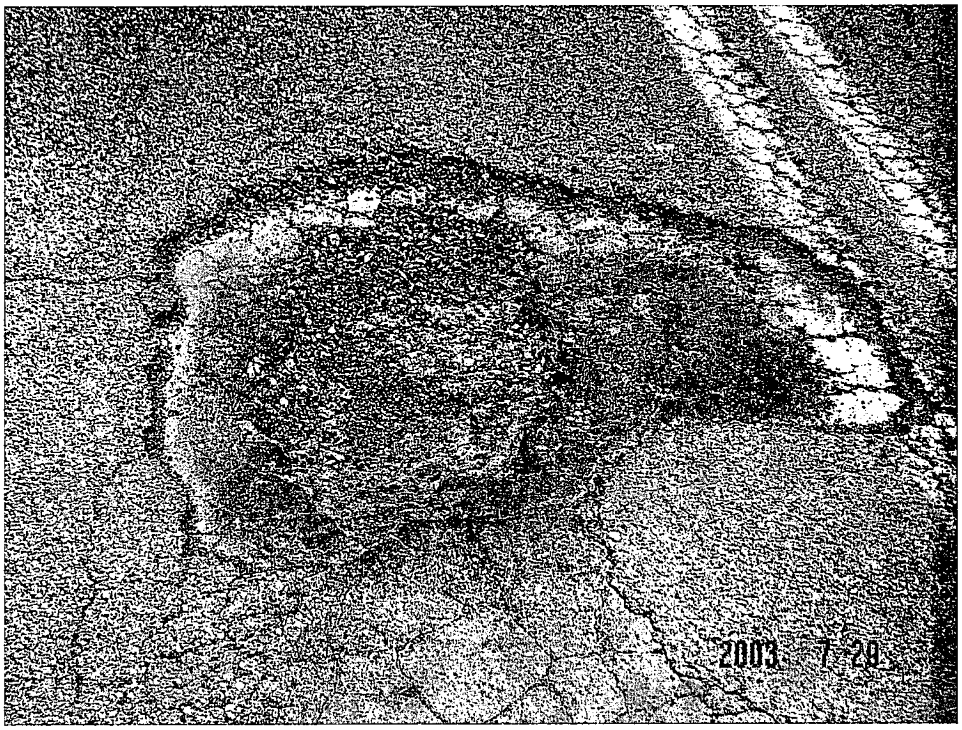


Photo 5
Medium Pothole

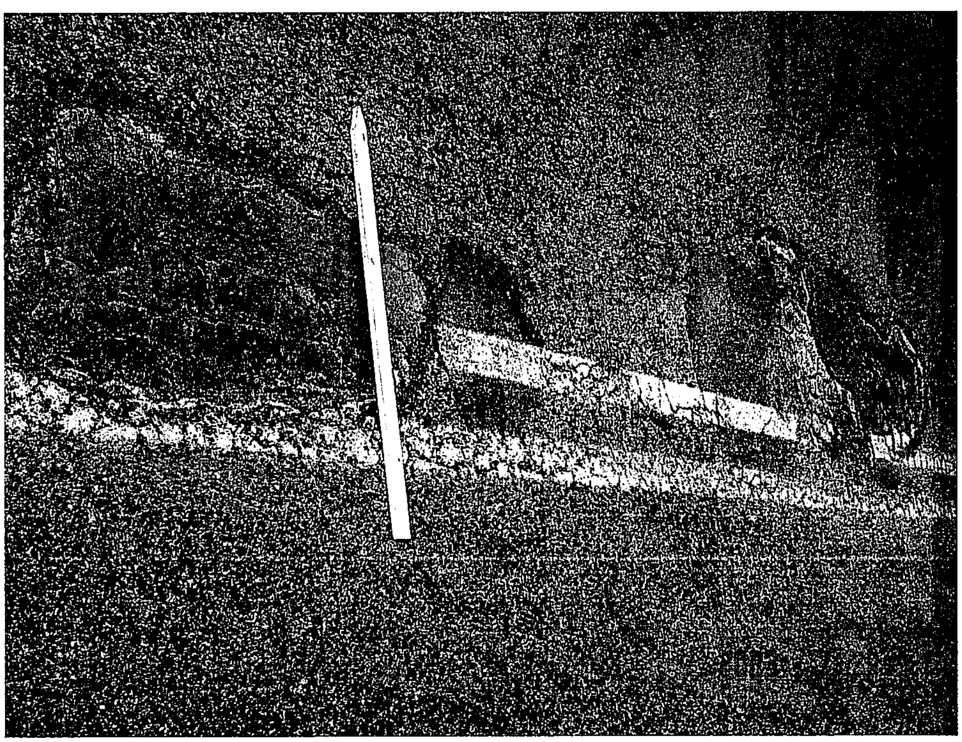


Photo 6
Series of Small to Medium
Potholes and Patching

ARCADIS

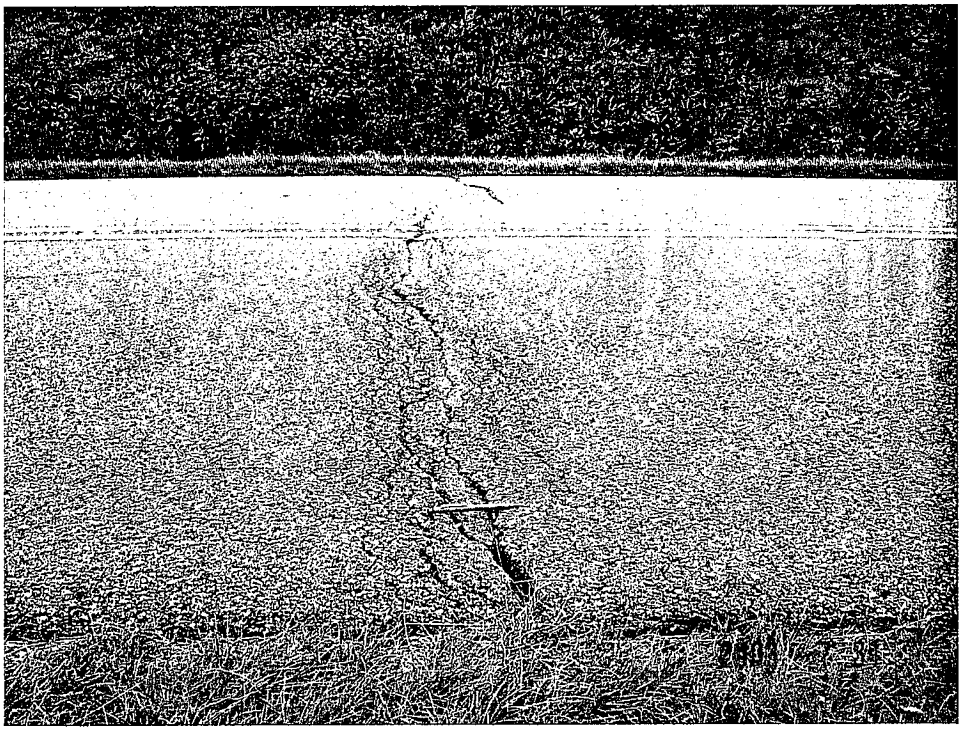


Photo 7
1/2-Inch Transverse Crack with Adjacent Fatigue Cracking

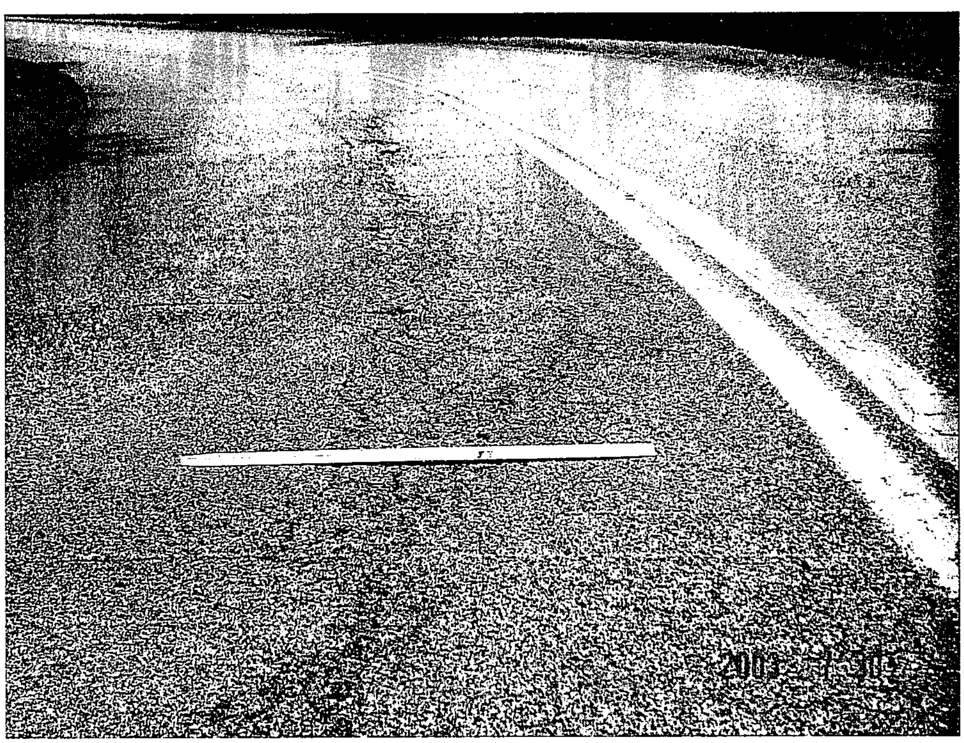


Photo 8
1/2-Inch Rutting in Wheel Path

Photo 9
High Severity Fatigue Cracking with Small Pothole in Wheel Path

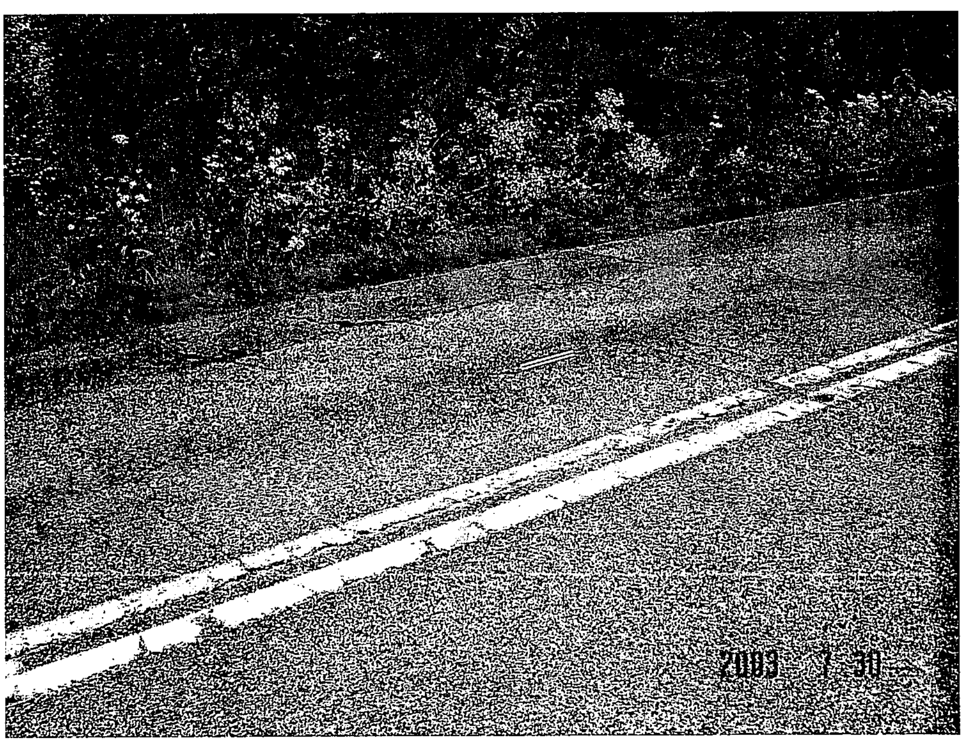


Photo 10
Block Cracking

ARCADIS

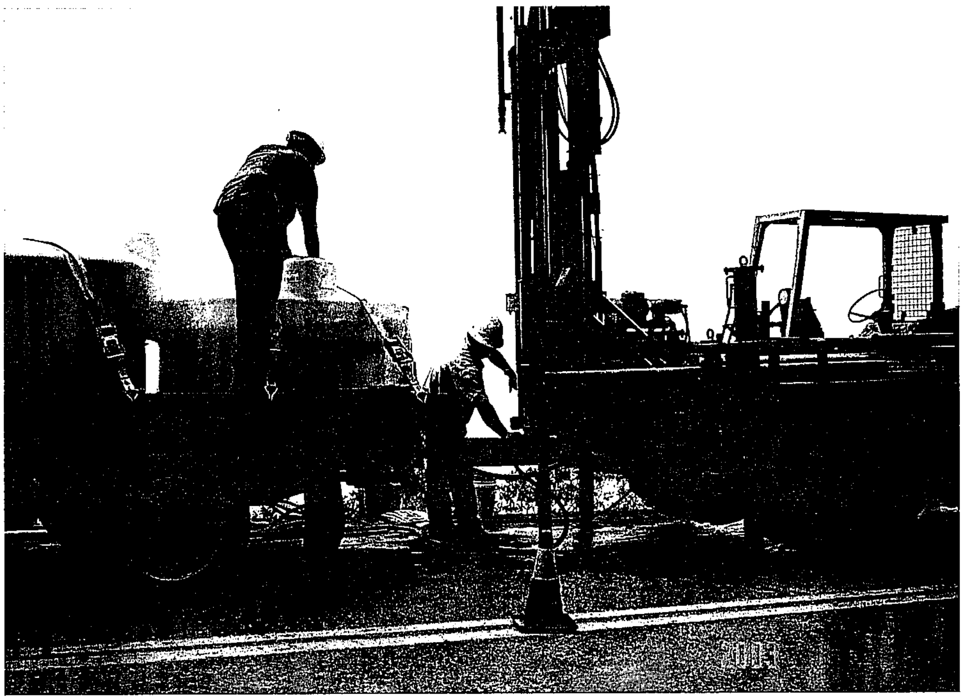


Photo 11
Rock Core Drilling

Photo 12
Dynamic Cone Penetration

Photo 13
Non-Destructive Testing (Falling Weight Deflectometer)

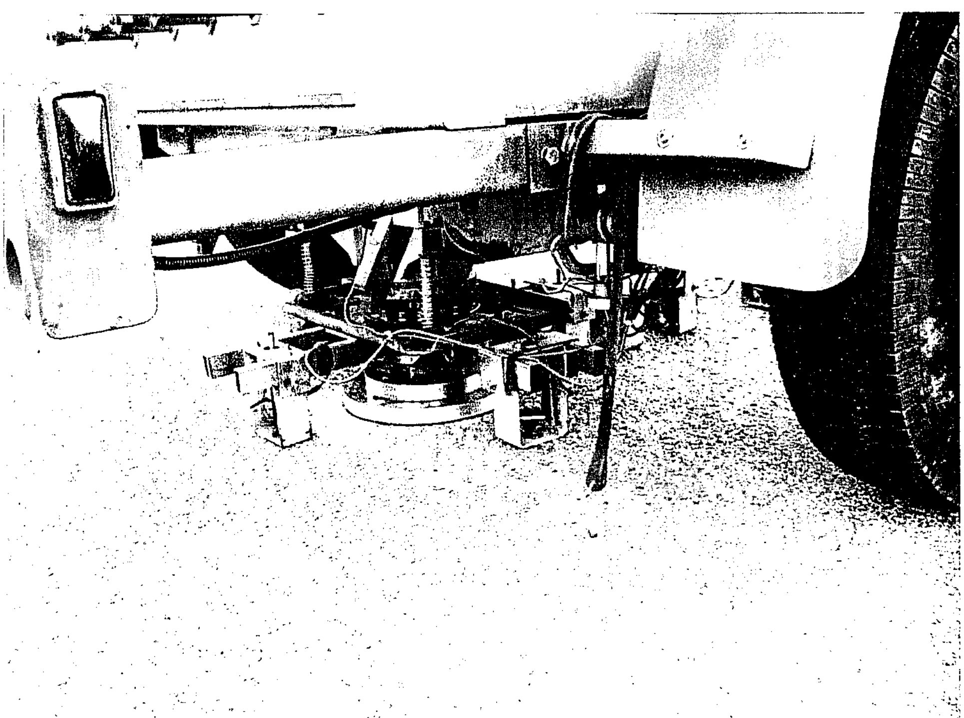


Photo 14
Falling Weight Deflectometer Apparatus

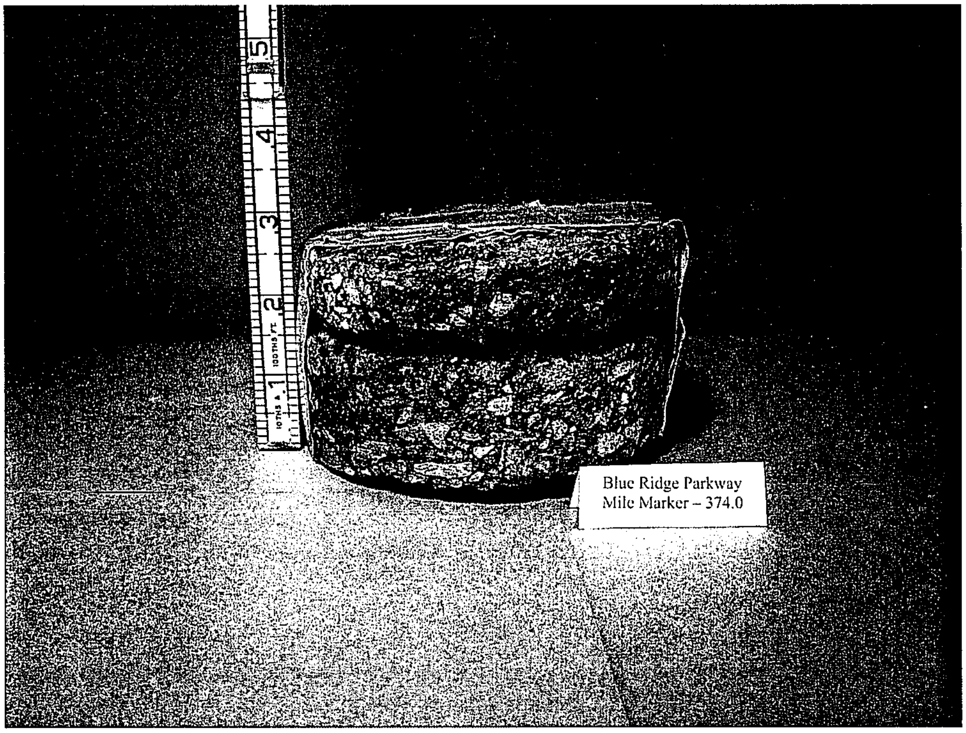


Photo 15
Additional Asphalt Cores
Mile Marker 374.0

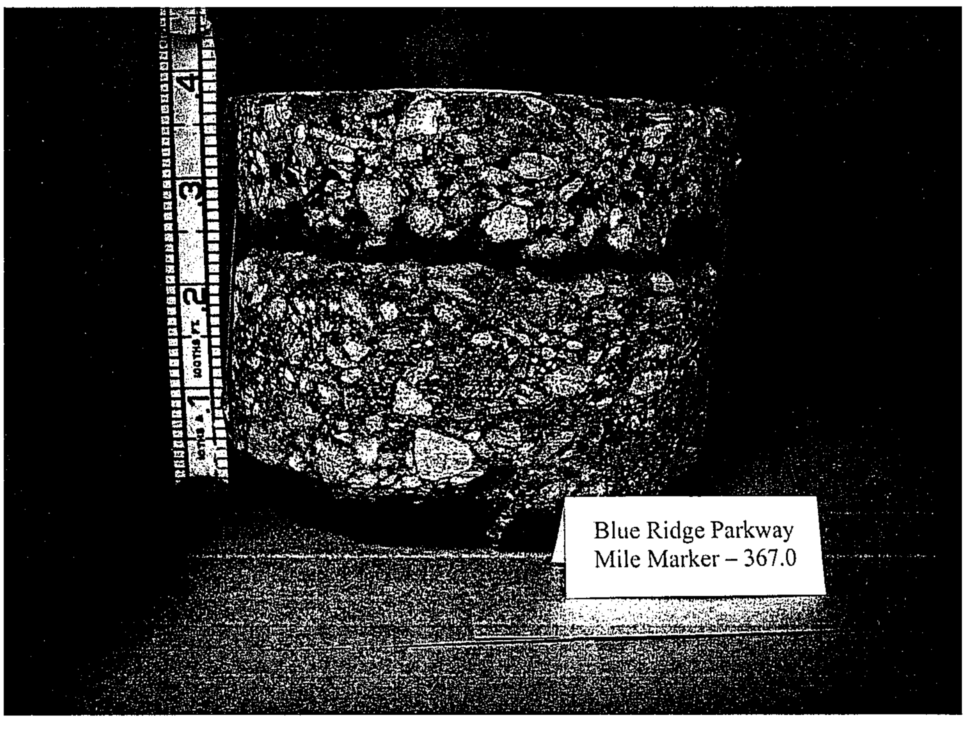


Photo 16
Additional Asphalt Cores
Mile Marker 367.0

Photo 17
Additional Asphalt Cores
Mile Marker 368.0

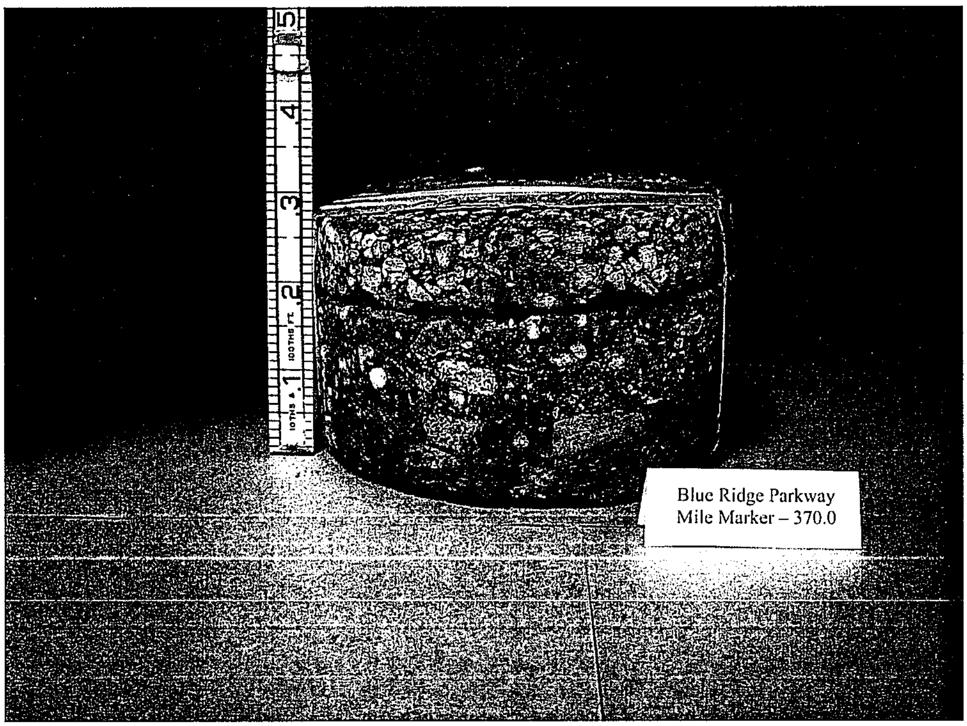


Photo 18
Additional Asphalt Cores
Mile Marker 370.0

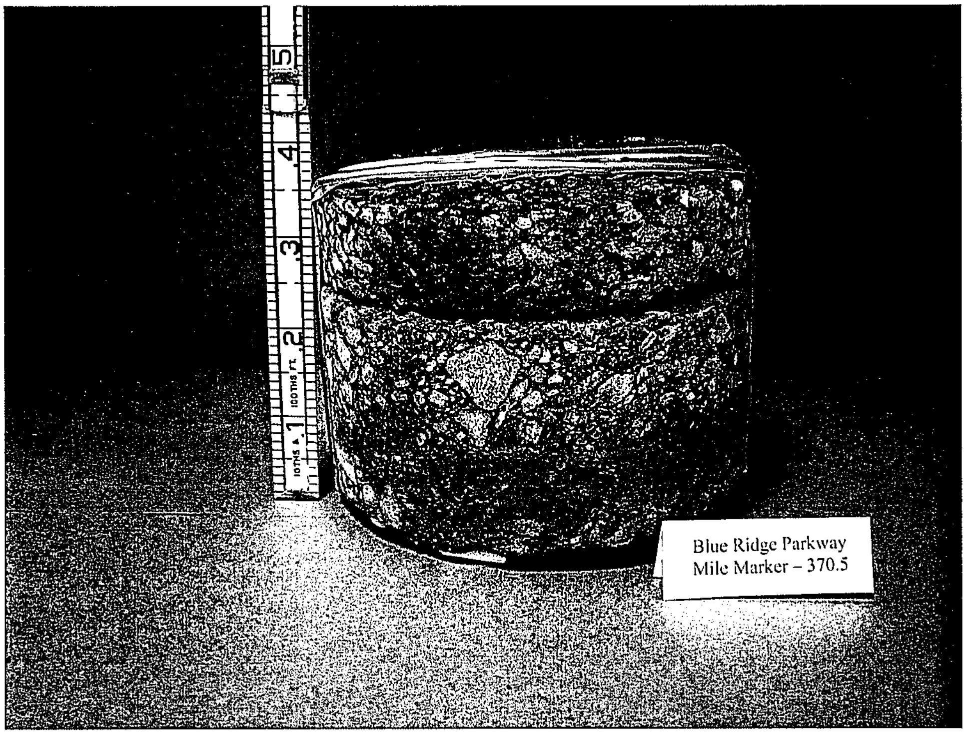


Photo 19
Additional Asphalt Cores
Mile Marker 370.5

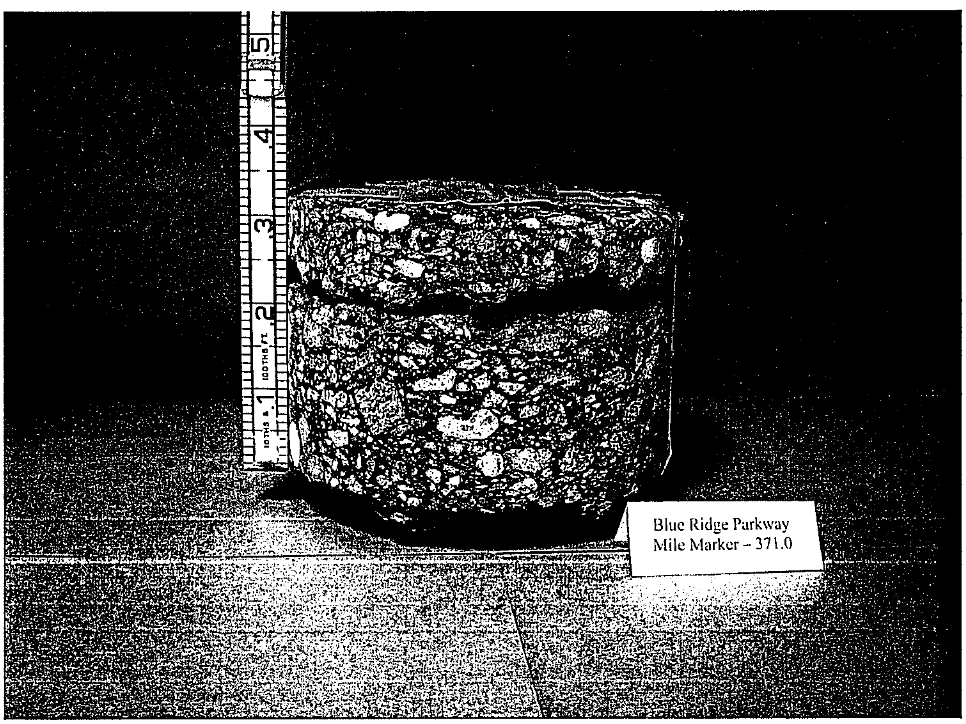


Photo 20
Additional Asphalt Cores
Mile Marker 371.0

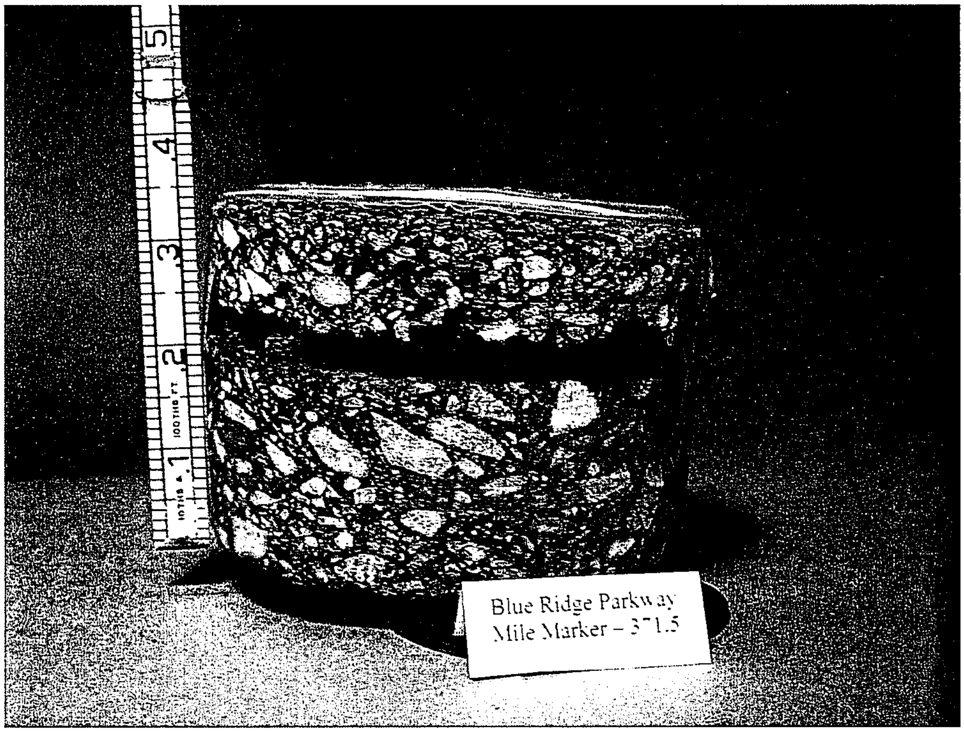


Photo 21
Additional Asphalt Cores
Mile Marker 371.5

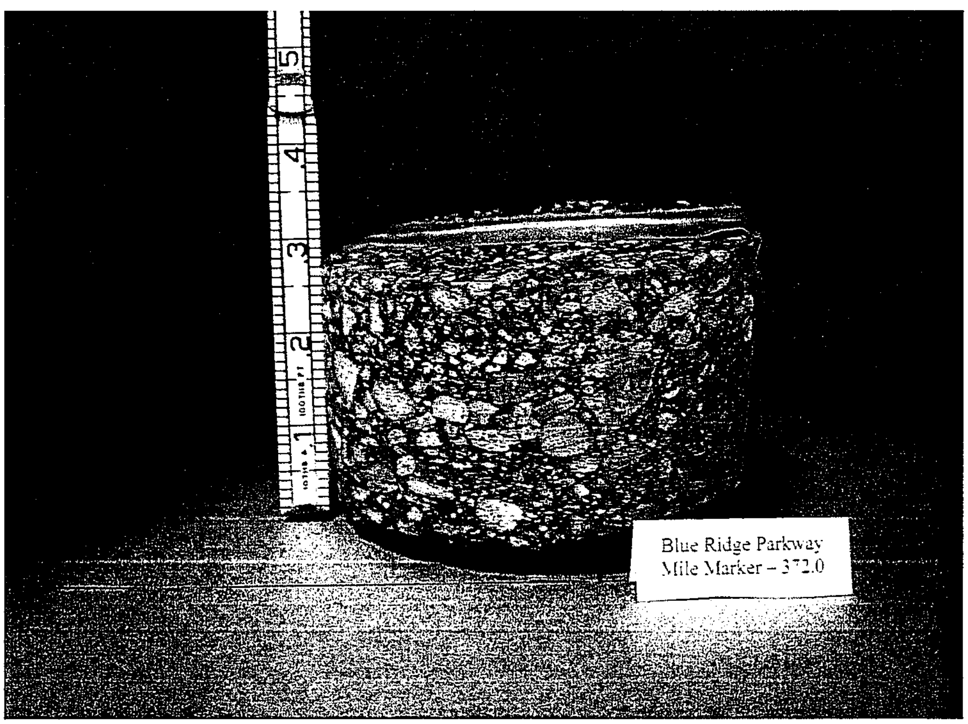


Photo 22
Additional Asphalt Cores
Mile Marker 372.0

Photo 23
Additional Asphalt Cores
Mile Marker 372.5

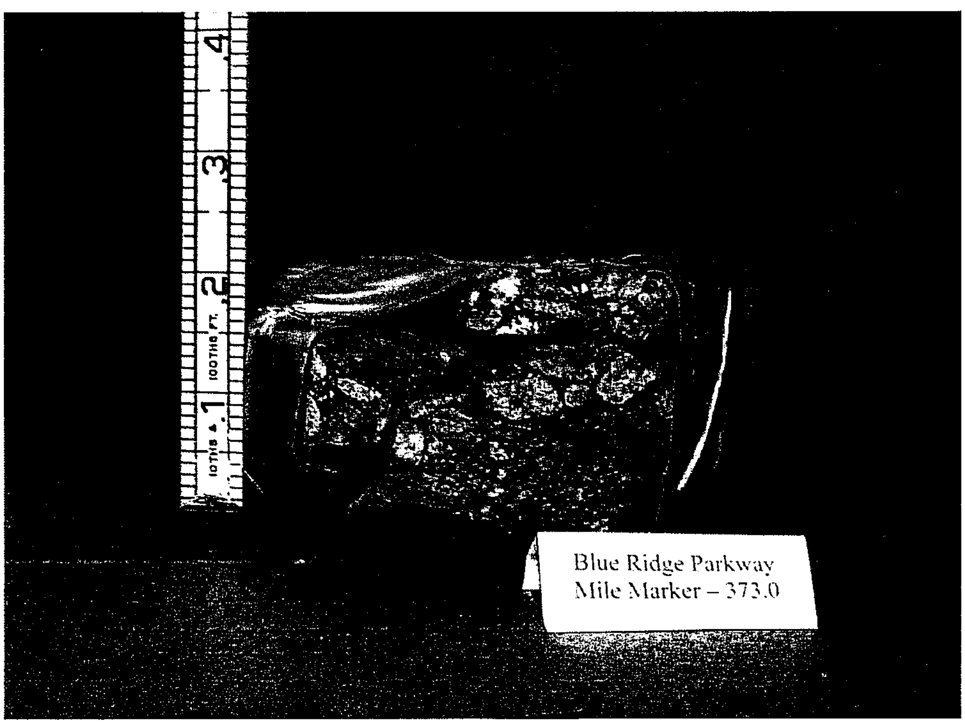


Photo 24
Additional Asphalt Cores
Mile Marker 373.0

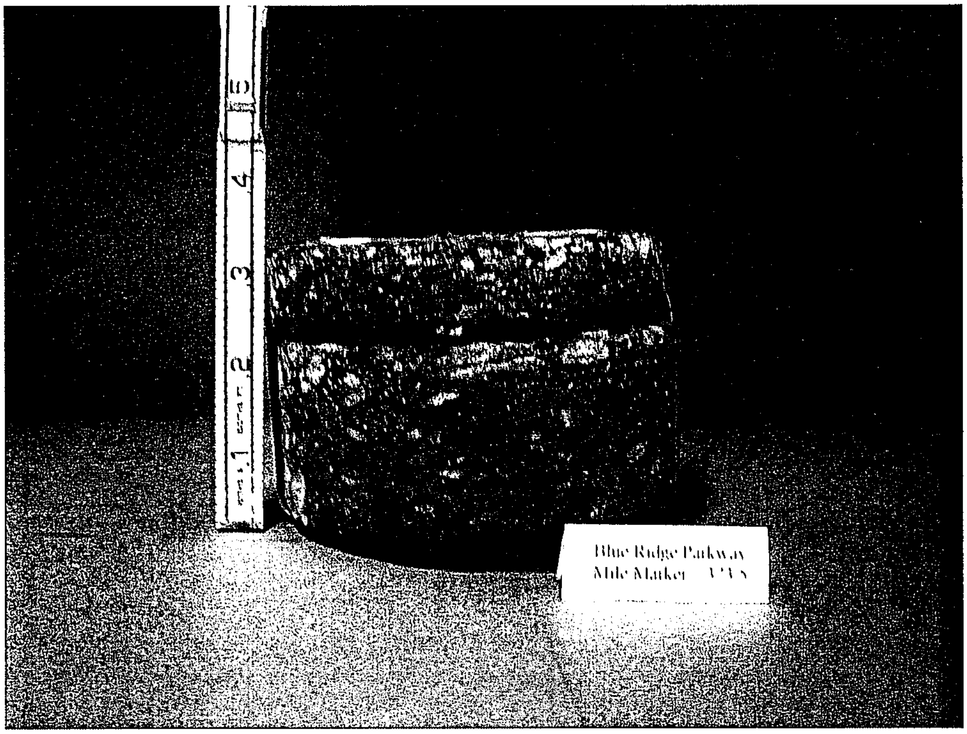


Photo 25
Additional Asphalt Cores
Mile Marker 373.5

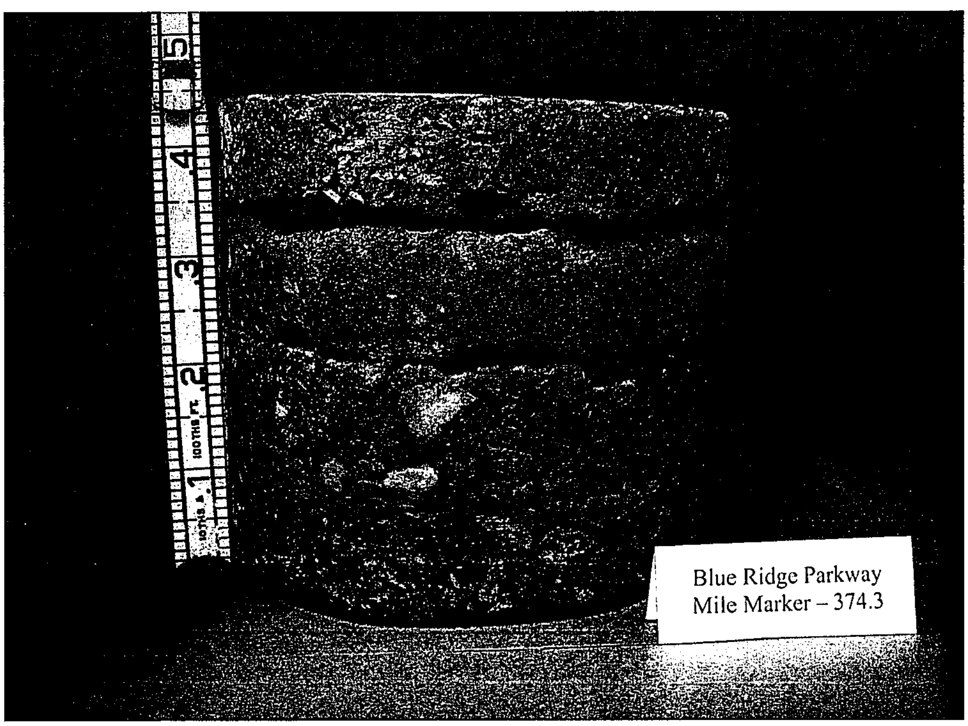


Photo 26
Additional Asphalt Cores
Mile Marker 374.3

ARCADIS

Project Photos

Rehabilitation of
Blue Ridge Parkway

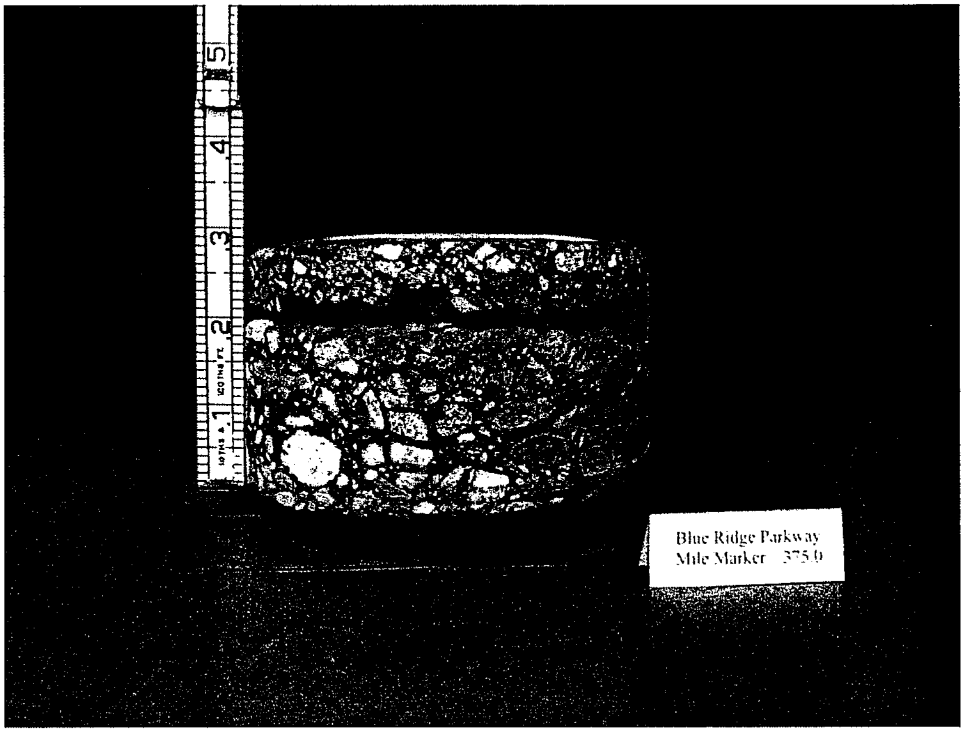


Photo 27
Additional Asphalt Cores
Mile Marker 375.0

Appendix C

Boring Logs

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 359/41+50 (B-1)**

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Tan orange clayey SILT (A-7-6)	28.8		1.0-2.5			
2								
2.5		Tan orange silty SAND (A-2-4)	21.6		2.5-4.0			
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 360/50+00 (B-2)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Dark brown sandy SILT (A-7-6)	67.9		1.0-2.5			
2.5		Dark brown silty SAND (A-2-4)	15.8		2.5-4.0		● (approx. 31)	11-15-16
4		Boring Terminated at 4 feet below ground surface.						

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 361/51+00 (B-3)**

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *1.66 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty SAND (A-2-4)	10.7		1.0-1.7			
		Auger refusal at 1.66 feet below ground surface.						
2								
3								
4								
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 362/10+50 (B-4)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	4.5					
2								
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 362/23+00 (B-5)

		Notes:
PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-4)	26.0					
2								
		Brown micaceous silty fine SAND (A-4)	32.9					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 362/51+00 (B-6)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Weathered Biotite Gneiss Schist (A-2-4)	7.3					
2								
			9.7					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 363/10+50 (B-7)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	11.1					
2								
			11.8					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT:

Blue Ridge Parkway
Section 2P
Asheville, NC

BORING LOG 363/34+00 (B-8)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*

Notes:
Auger refusal was not encountered.
Groundwater was not encountered in boring at time of driling.

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND with rock fragments (A-2-4)	17.8					
2			10.4					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 364/3+50 (B-9)**

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *1.75 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND with rock fragments (A-2-4)	2.8					17-50/3"
2		Auger refusal at 1.75 feet below ground surface.						
3								
4								
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 364/36+00 (B-10)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		No Sample	11.1					
2								
			5.0					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

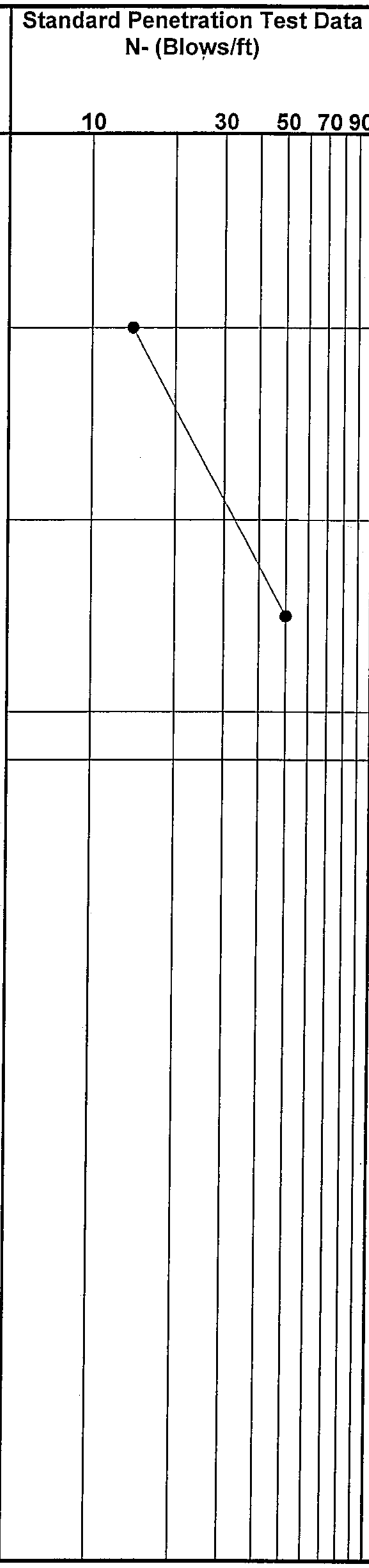
- Initial Depth to Water

- Final Depth to Water

PROJECT:	BORING LOG 365/11+00 (B-11)
Blue Ridge Parkway *Section 2P* *Asheville, NC*	

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *3.25 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft)	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	22.2					7-7-7
2								
		No Recovery	10.3					17-50/3"
3								
		Auger refusal at 3.25 feet below ground surface.						
4								
5								
6								
7								



ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT:	BORING LOG 366/11+00 (B-12)
Blue Ridge Parkway *Section 2P* *Asheville, NC*	

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	14.6					10-9-11
2			12.8					6-7-8
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 366/15+00 (B-13)**

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 2.5 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND with rock fragments (A-2-4)	9.1					18-50/3"
2								
		No Recovery Auger refusal at 2.5 feet below ground surface.						50/0"
3								
4								
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 366/43+00 (B-14)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 2.83 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft)	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND with rock fragments (A-2-4)	5.5					18-16-50/2"
2		Dark gray gravelly silty fine to coarse SAND (A-2-4)	4.2					50/4"
3		Auger refusal at 2.83 feet below ground surface.						
4								
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 367/21+50 (B-15)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		No Sample						
2		No Sample						
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 367/39+00 (B-16)**

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Gray brown gravelly silty fine to medium SAND (A-2-4)	11.1					10-18-21
2								
			9.9					10-20-42
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 368/12+50 (B-17)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		White tan silty fine to coarse SAND (A-2-4)	19.9					
2								
			20.6					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water
- Final Depth to Water

BORING LOG 368/38+00 (B-18)

PROJECT: *Blue Ridge Parkway*
Section 2P
Asheville, NC

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of drilling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *2.5 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	15.2					
2								
2.5		Auger refusal at 2.5 feet below ground surface.						
3								
4								
5								
6								
7								

ARCADIS GERAGHTY&MILLER

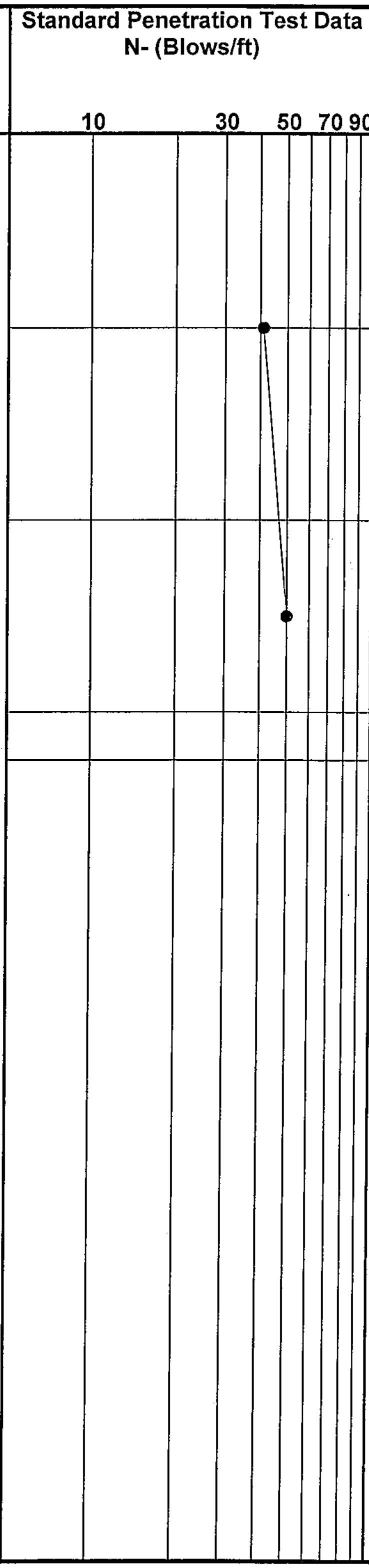
- Initial Depth to Water

- Final Depth to Water

PROJECT: *Blue Ridge Parkway* *Section 2P* *Asheville, NC*	**BORING LOG 369/4+50** **(B-19)**

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *3.25 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown slightly micaceous silty fine to coarse SAND (A-2-4)	12.2					3-17-24
2.5		Refused on a boulder	4.7					38-50/4"
3.25		Auger refusal at 3.25 feet below ground surface.						



ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 369/14+00 (B-20)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	9.9					
2								
		Brown micaceous silty fine SAND with rock fragments (A-2-4)	9.6					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 369/39+00 (B-21)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 1 foot	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
		From auger cuttings - Brown silty fine SAND (A-2-4)	5.5					
1		Auger refusal at 1 foot below ground surface.						
2								
3								
4								
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 370/13+00 (B-22)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Red brown micaceous silty fine SAND (A-2-4)	10.3					11-13-9
2			8.0					8-6-5
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT:
Blue Ridge Parkway
Section 2P
Asheville, NC

BORING LOG 370/38+00 (B-23)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *2.75 feet*
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*

Notes:
Groundwater was not encountered in boring at time of driling.

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Gray brown silty fine SAND (A-2-4)	9.7					
2			7.2				●	50/3"
3		Auger refusal at 2.75 feet below ground surface.						
4								
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water
- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 371/15+00 (B-24)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Red brown micaceous gravelly silty fine to medium SAND (A-2-4)	11.3					
2			14.9					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 371/25+00 (B-25)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Dark brown micaceous silty fine SAND (A-2-4)	10.9					4-5-7
2								
2.5		Dark brown micaceous silty fine SAND (A-4)	28.3					8-4-2
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC			BORING LOG 371/30+00 (B-26)
PROJECT NO.: CT052885.0000.00008	ELEVATION:		Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet		
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc		
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550		

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	11.3					
2								
			6.7					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 372/14+00 (B-27)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 2 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Red brown miaceous sitly fine SAND (A-4)	17.9					
2		Auger refusal at 2 feet below ground surface.						
3								
4								
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 372/39+50 (B-28)

PROJECT NO.: *CT052885.0000.00008*	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	BORING DEPTH: *4 feet*	
DATE DRILLED: *8/6/2003*	DRILLER: *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	DRILL RIG: *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	12.6					7-11-5
2								
			18.0					8-9-11
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water
- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 373/17+00 (B-29)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	BORING DEPTH: 2.5 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown micaceous silty fine SAND (A-2-4)	13.4					
2								
		Auger refusal at 2.5 feet below ground surface.						
3								
4								
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 373/37+00 (B-30)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown silty fine SAND (A-4)	19.3					
2								
			21.2					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

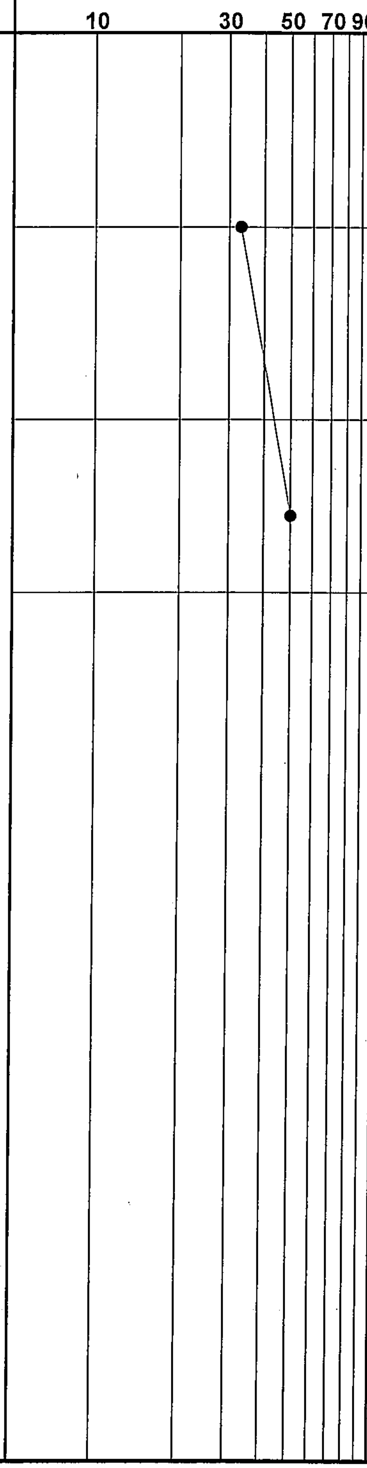
- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 373/49+50 (B-31)**

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 2.9 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft)	Blow Count
0		Asphalt						
1		Brown slightly micaceous silty SAND (A-4)	16.6					8-12-21
2.5		Weathered Biotite Gneiss Schist Rock Fragments (A-2-4)	7.0					50/5"
2.9		Auger refusal at 2.9 feet below ground surface.						



ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 374/36+00 (B-32)

PROJECT NO.: *CT052885.0000.00008*	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	BORING DEPTH: *4 feet*	
DATE DRILLED: *8/6/2003*	DRILLER: *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	DRILL RIG: *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown slightly micaceous silty SAND (A-4)	19.7					
2.5		Weathered Biotite Gneiss Schist rock fragments (A-2-4)	3.1					
4		Boring Terminated at 4 feet below ground surface.						

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water
- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 375/0+00 (B-33)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Red brown micaceous silty Sand (A-4)	14.2					
2								
		Weathered Biotite Gneiss Schist rock fragments (A-2-4)	0.9					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG PA/20+50 (B-34)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 4 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown silty fine to medium SAND with rock fragments (A-2-4)	7.9					
2								
		Brown silty fine to medium SAND (A-2-4)	20.0					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG PA/36+80 (B-35)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown silty fine SAND (A-2-4)	27.4					
2								
			27.8					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 361.8 L (B-36)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: Dewayne Ponds	**BORING DEPTH:** 18.3 feet	
DATE DRILLED: 8/8/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: NQ Rock Core	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Topsoil						
		Shot rock and sand						
2.5		Pull 1 - from 2.0 to 8.0 feet. Material consisted of shot rock and sand Run - 6.0 feet Rec - 50% RQD - 50%						
5								
7.5		Pull 2 through 4 are short run with difficult drilling - from 8.0 to 13.0 feet. Material consisted of shot rock and sand.						
10								
12.5		Pull 5 - from 13.0 to 18.0 feet. Material consisted of shot rock and dark soil Run - 5.0 feet Rec - 14% RQD - 14%						
15								
17.5		Pull 6 - from 18.0 to 20.0 feet.						

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC		BORING LOG 361.8 L (B-36)
PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Dewayne Ponds	BORING DEPTH: 18.3 feet	
DATE DRILLED: 8/8/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: NQ Rock Core	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
20 22.5		Material consisted of shot rock and sand from 20.0 to 23.0 feet. Metagraywake with interbedded mica schist Run - 5.0 feet Rec - 68% RQD - 68%						
25		Pull 7 - from 23.0 to 27.2 feet. Metagraywake with interbedded mica schist Run - 4.2 feet Rec - 100% RQD - 100%						
27.5 30 32.5 35		Coring terminated at 27.2 feet below ground surface.						

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 361.8 R (B-37)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: Dewayne Ponds	BORING DEPTH: 18.3 feet	
DATE DRILLED: 8/8/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: NQ Rock Core	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
		Shot rock and sand						
2.5								
5		Pull 1 - from 4.0 to 8.0 feet. Material consisted of shot rock and sand Run - 4.0 feet Rec - 25% RQD - 25%						
7.5								
10		Pull 2 - from 8.0 to 12.0 feet. Material consisted of shot rock and sand Run - 4.0 feet Rec - 25% RQD - 25%						
12.5		Pull 3 - from 12.0 to 17.0 feet. Material consisted of shot rock and sand Run - 5.0 feet Rec - 20% RQD - 20%						
15								
17.5		Pull 4 - from 17.0 to 22.0 feet. Material consisted of shot rock and sand Run - 5.0 feet						

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water
- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 361.8 R (B-37)

PROJECT NO.: *CT052885.0000.00008*	ELEVATION:	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Dewayne Ponds*	BORING DEPTH: *18.3 feet*	
DATE DRILLED: *8/8/2003*	DRILLER: *S&ME, Inc*	
DRILLING METHOD: *NQ Rock Core*	DRILL RIG: *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
		Rec - 36% RQD - 36%						
20								
22.5		Pull 5 - from 22.0 to 27.0 feet. Material consists of shot rock and sand. Run - 5.0 feet Rec - 36% RQD - 36%						
25								
27.5		Pull 6 - from 27.0 to 32.0 feet. Metagraywake with interbedded mica schist and mica Gneiss. Run - 5.0 feet Rec - 100% RQD - 100%						
30								
32.5		Coring terminated at 32.0 feet below ground surface.						
35								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 362.8 L (B-38)

PROJECT NO.: *CT052885.0000.00008*	ELEVATION:	Notes: Groundwater was not encountered in boring at time of drilling.
LOGGED BY: *Dewayne Ponds*	BORING DEPTH: *18.3 feet*	
DATE DRILLED: *8/7/2003*	DRILLER: *S&ME, Inc*	
DRILLING METHOD: *NQ Rock Core*	DRILL RIG: *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Topsoil and Sand Augered to 2 feet through topsoil, sand, and boulders						
2.5 5 7.5		Pull - 1 from 2.0 to 8.3 feet. Material consisted of cobble and boulder fill. Run - 6.3 feet Rec - 29%						
10		Pull - 2 from 8.3 to 13.3 feet. Material consisted of boulder fill with voids to approximately 12 feet. the final 1.3 feet is a Mica Schist with Horn Blend Gneiss Run - 5.0 feet Rec - 32%						
12.5								
15 17.5		Pull - 3 from 13.3 to 18.3 feet. Mica Schist with Horn Blend Gneiss Run - 5.0 feet Rec - 100% RQD - 100%						

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	**BORING LOG 362.8 L (B-38)**

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Dewayne Ponds*	**BORING DEPTH:** *18.3 feet*	
DATE DRILLED: *8/7/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *NQ Rock Core*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
		Coring terminated at 18.3 feet below ground surface.						
20								
22.5								
25								
27.5								
30								
32.5								
35								

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 362.8 R (B-39)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: Dewayne Ponds	BORING DEPTH: 23.4 feet	
DATE DRILLED: 8/8/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: NQ Rock Core	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
		Drill through pavement and set NW casing to 4.0 feet. Material consisted of sand and boulders						
2.5								
		Pull 1 - from 4.0 to 12.2 feet. Material consisted of boulder fill with soil and clear voids in between. Run - 8.2 ft Rec - 18% RQD - 18%						
5								
7.5								
10								
12.5		Pull 2 - from 12.2 to 17.2 feet. Material consisted of boulder fill with soil and clear voids in between. Run - 5.0 feet Rec - 12% RQD - 12%						
15								
17.5		Pull 3 - from 17.2 to 22.2 feet. Material consisted of bulder fill with soil and clear voids in between.						

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT:

Blue Ridge Parkway
Section 2P
Asheville, NC

BORING LOG 362.8 R (B-39)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**
LOGGED BY: *Dewayne Ponds*	**BORING DEPTH:** *23.4 feet*
DATE DRILLED: *8/8/2003*	**DRILLER:** *S&ME, Inc*
DRILLING METHOD: *NQ Rock Core*	**DRILL RIG:** *CME 550*

Notes:
Groundwater was not encountered in boring at time of drilling.

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
		Run - 5.0 feet Rec - 20% RQD - 20%						
20								
22.5		Pull 4 - from 22.2 to 23.4 feet. Metagraywake with seven joints ranging from 15 to 30 degrees. Run - 1.2 feet Rec - 116% RQD - 116%						
25		Coring terminated at 23.4 feet below ground surface.						
27.5								
30								
32.5								
35								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 363.4 L (B-40)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Dewayne Ponds*	**BORING DEPTH:** *18.3 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *NQ Rock Core*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Topsoil						
		Shot rock and sand						
2.5								
5		Pull 1 - from 5.0 to 8.0 feet. Material consisted of shot rock and sand Run - 3.0 feet Rec - 16% RQD - 16%						
7.5		Pull 2 - from 8.0 to 13.0 feet. Material consisted of shot rock and sand Run - 5.0 feet Rec - 36% RQD - 36%						
10								
12.5		Pull 3 - from 13.0 to 18.0 feet. Material consisted of shot rock and sand Run - 5.0 feet Rec - 6% RQD - 0%						
15								
17.5		Pull 4 - from 18.0 to 23.0 feet.						

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway, Section 2P, Asheville, NC	BORING LOG 363.4 L (B-40)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: Dewayne Ponds	BORING DEPTH: 18.3 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: NQ Rock Core	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
20		Material consisted of shot rock and sand to 21.5 feet and metagraywake bedrock to 23.0 feet Run - 5.0 feet Rec - 40% RQD - 18%						
22.5 25		Pull 5 - from 23.0 to 28.0 feet. white Pegmatite intrusion Run - 5.0 feet Rec - 100% RQD - 86%						
27.5 30 32.5		Pull 6 - from 28.0 to 33.0 feet. White Pegmatite Intrusion Run - 5.0 feet Rec - 100% RQD - 84%						
35		Coring terminated at 33.0 feet below ground surface.						

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 363.4 R (B-41)

PROJECT NO.: *CT052885.0000.00008*	ELEVATION:	**Notes:** Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Dewayne Ponds*	BORING DEPTH: *18.3 feet*	
DATE DRILLED: *8/7/2003*	DRILLER: *S&ME, Inc*	
DRILLING METHOD: *NQ Rock Core*	DRILL RIG: *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
		Shot rock and sand						
2.5								
5		Pull 1 - from 5.2 to 12.2 feet. Material consisted of shot rock and sand Run - 7.0 feet Rec - 32% RQD - 10%						
7.5								
10								
12.5		Pull 2 - from 12.2 to 17.2 feet. Material consisted of shot rock and sand Run - 5.0 feet Rec - 36% RQD - 7%						
15								
17.5		Pull 3 - from 17.2 to 22.2 feet. Material consisted of shot rock and sand Run - 5.0 feet						

ARCADIS GERAGHTY & MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG 363.4 R (B-41)

PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Groundwater was not encountered in boring at time of driling.
LOGGED BY: Dewayne Ponds	BORING DEPTH: 18.3 feet	
DATE DRILLED: 8/7/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: NQ Rock Core	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
		Rec - 64% RQD - 0%						
20								
22.5		Pull 4 - from 22.2 to 27.2 feet. Material consisted of shot rock and sand Run - 5.0 feet Rec - 60% RQD - 10%						
25								
27.5		Pull 5 - from 27.2 to 32.2 feet. Metagraywake fine to coarse grained with a pegmatite intrusion. Run - 5.0 feet Rec - 88% RQD - 64%						
30								
32.5		Coring terminated at 33.0 feet below ground surface.						
35								

ARCADIS GERAGHTY & MILLER

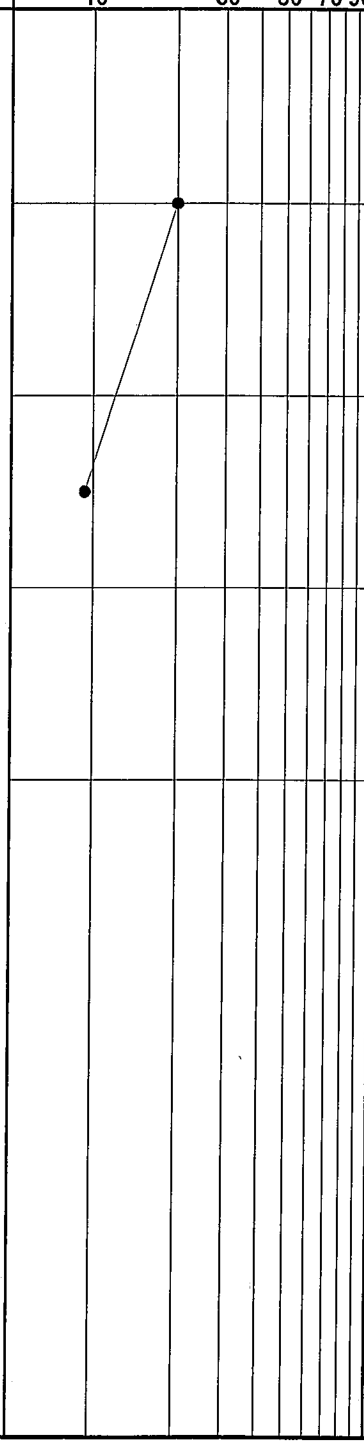
- Initial Depth to Water

- Final Depth to Water

PROJECT:	BORING LOG Visitor Center (B-VC)
Blue Ridge Parkway *Section 2P* *Asheville, NC*	

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of driling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown silty fine to medium SAND (A-2-4)	20.5					7-11-9
2								
			29.4					5-5-4
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								



Page: 1 of 1

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water
- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC		BORING LOG Picnic Parking (B-PA)
PROJECT NO.: CT052885.0000.00008	ELEVATION:	Notes: Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	BORING DEPTH: 4 feet	
DATE DRILLED: 8/6/2003	DRILLER: S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	DRILL RIG: CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown tan silty fine to medium SAND (A-2-4)	8.7					
2								
		Gray brown tan silty fine to medium SAND with rock fragments (A-2-4)	4.9					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG Craggy Dome (B-CDU)

PROJECT NO.: *CT052885.0000.00008*	**ELEVATION:**	**Notes:** Auger refusal was not encountered. Groundwater was not encountered in boring at time of drilling.
LOGGED BY: *Scott Manning*	**BORING DEPTH:** *4 feet*	
DATE DRILLED: *8/6/2003*	**DRILLER:** *S&ME, Inc*	
DRILLING METHOD: *4.25" Hollow Stem Augers*	**DRILL RIG:** *CME 550*	

DEPTH (ft)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Brown red silty fine SAND (A-2-4)	10.0					
2								
		Soft (no recovery) cuttings recorded as - Brown silty fine SAND (A-2-4)	0.8					
3								
4		Boring Terminated at 4 feet below ground surface.						
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

PROJECT: Blue Ridge Parkway Section 2P Asheville, NC	BORING LOG Craggy Dome (B-CDL)

PROJECT NO.: CT052885.0000.00008	**ELEVATION:**	**Notes:** Groundwater was not encountered in boring at time of drilling.
LOGGED BY: Scott Manning	**BORING DEPTH:** 2.5 feet	
DATE DRILLED: 8/6/2003	**DRILLER:** S&ME, Inc	
DRILLING METHOD: 4.25" Hollow Stem Augers	**DRILL RIG:** CME 550	

DEPTH (ft.)	GRAPHIC LOG	Soil Description	W OR PPR	WATER LEVEL	SAMPLE DEPTH	ELEV.	Standard Penetration Test Data N- (Blows/ft) 10 30 50 70 90	Blow Count
0		Asphalt						
1		Red brown silty fine to medium SAND (A-2-4)	33.1					
2								
		Auger refusal at 2.5 feet below ground surface.						
3								
4								
5								
6								
7								

ARCADIS GERAGHTY&MILLER

- Initial Depth to Water

- Final Depth to Water

Appendix D

Field Test Results

DCP TEST DATA

File Name: M359S41+50

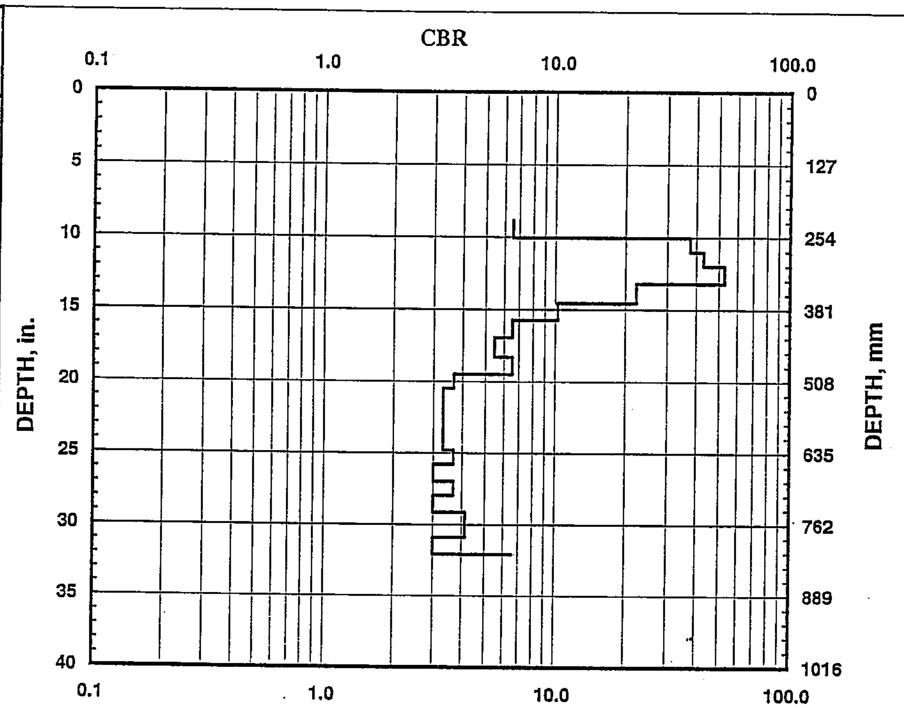
Project: *BLUE RIDGE PARKWAY*
Location: M359 STA 41+50

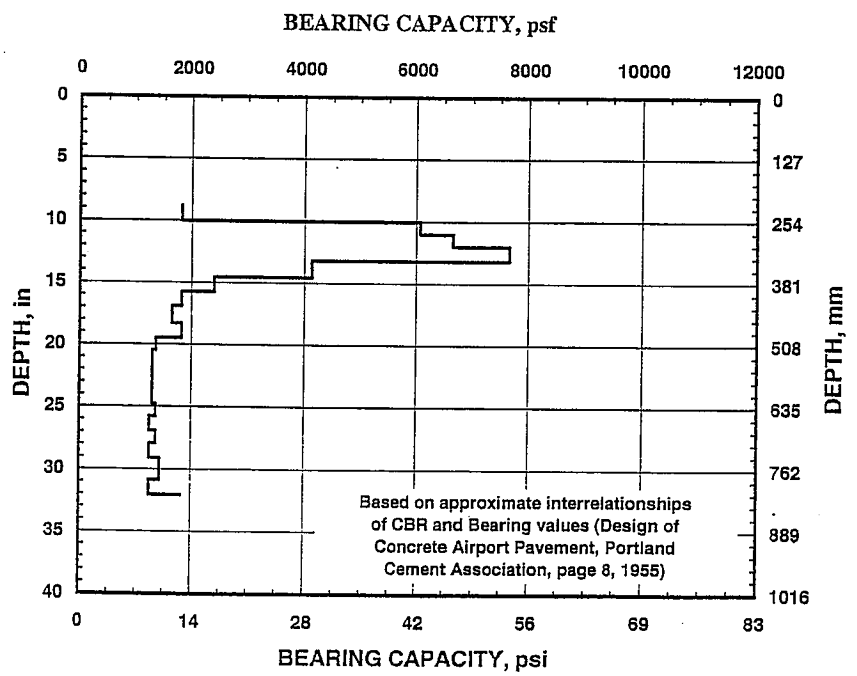
Date: 6-Aug-03
Soil Type(s): ML with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	225	2
2	255	2
8	280	2
9	305	2
13	335	2
7	370	2
3	400	2
2	430	2
2	465	2
2	495	2
1	520	2
2	575	2
2	630	2
1	655	2
1	685	2
1	710	2
1	740	2
2	785	2
1	815	2





DCP TEST DATA

File Name: M360S50+00

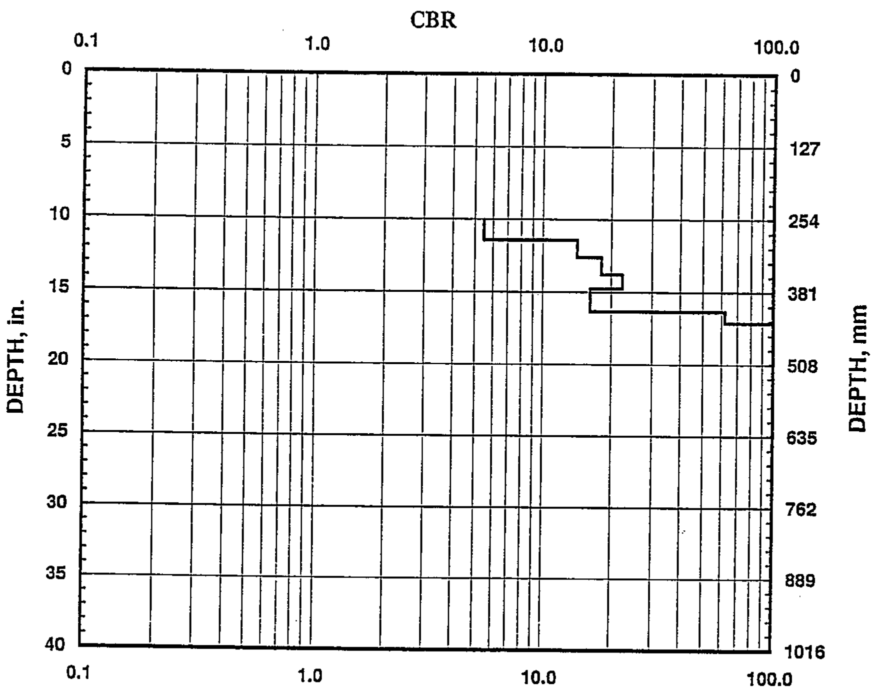
Project: *BLUE RIDGE PARKWAY*
Location: M360 STA 50+00

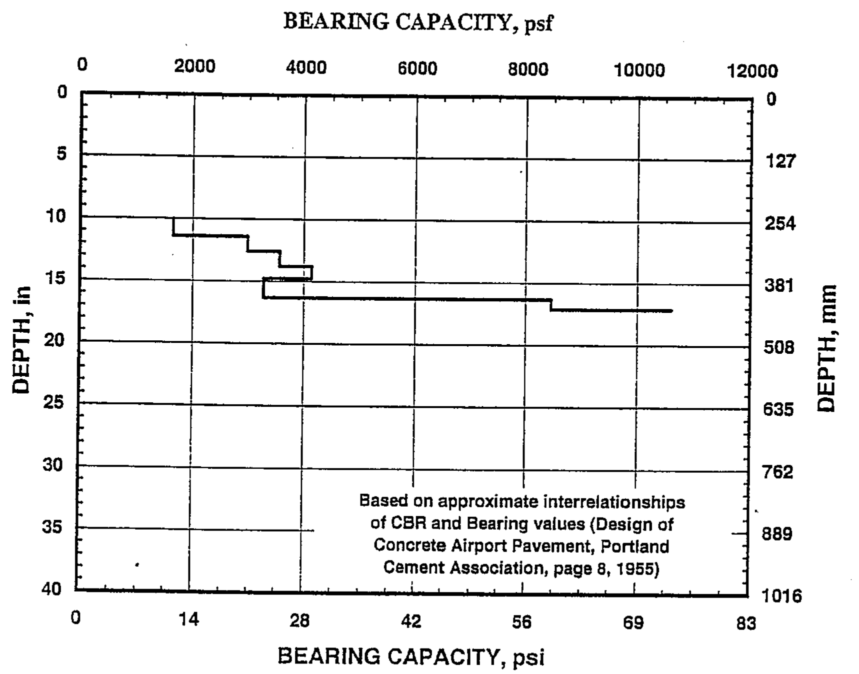
Date: 6-Aug-03
Soil Type(s): ML with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	255	2
2	290	2
4	320	2
5	350	2
5	375	2
6	415	2
10	435	2





DCP TEST DATA

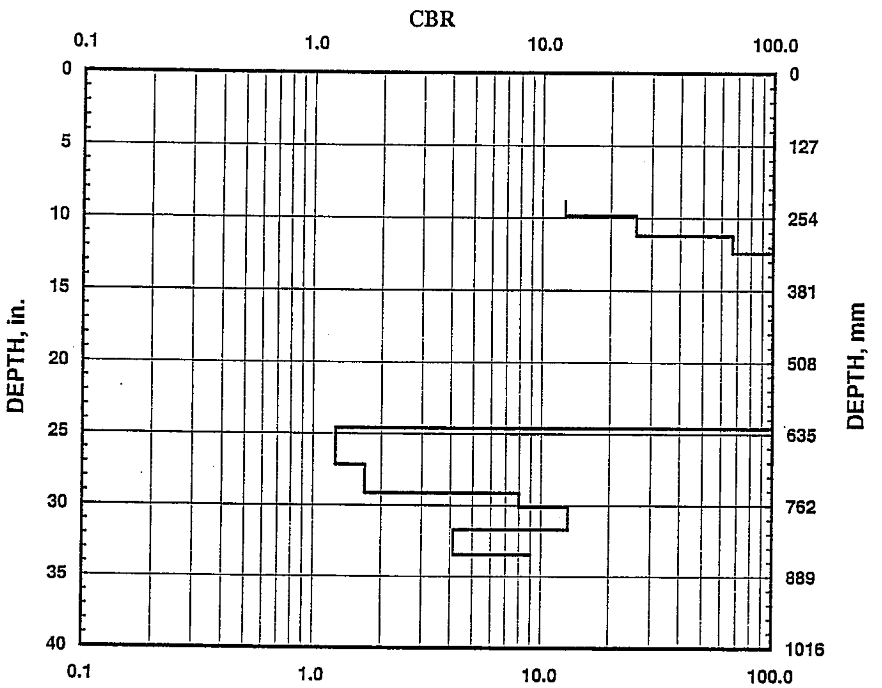
File Name: M362S10+50

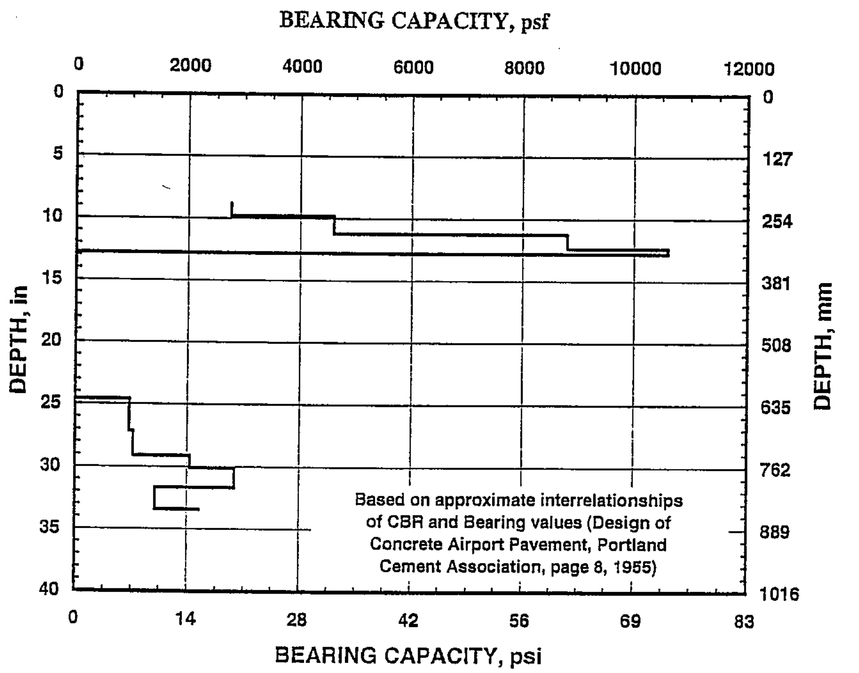
Project: *BLUE RIDGE PARKWAY*
Location: M362 STA 10+50
Date: 6-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	225	2
3	250	2
8	285	2
16	315	2
10	325	2
0	625	2
1	690	2
1	740	2
2	765	2
5	805	2
2	850	2





DCP TEST DATA

File Name: M362S23+00

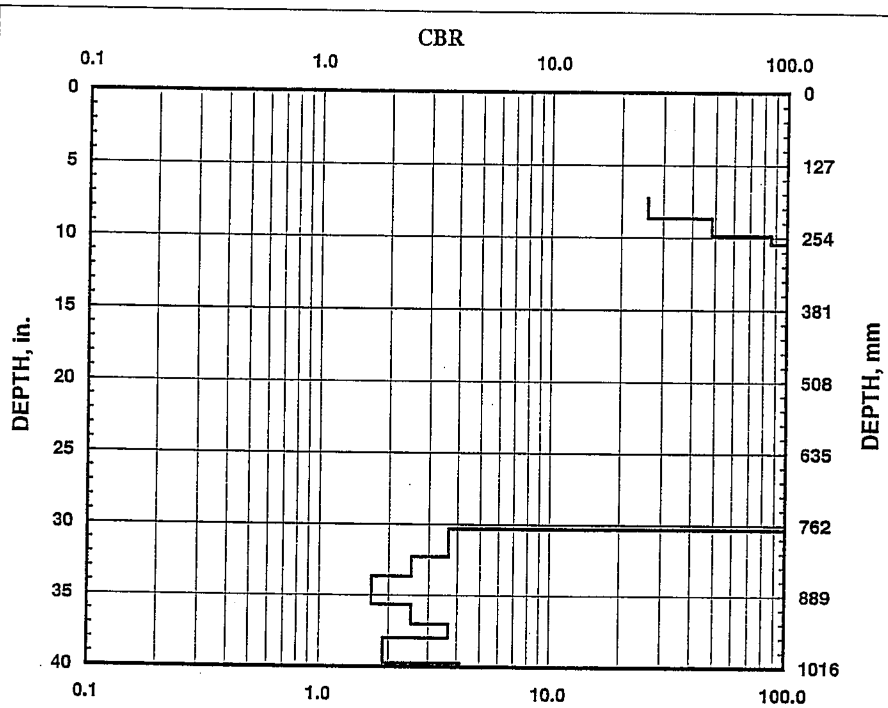
Project: *BLUE RIDGE PARKWAY*
Location: M362 STA 23+00

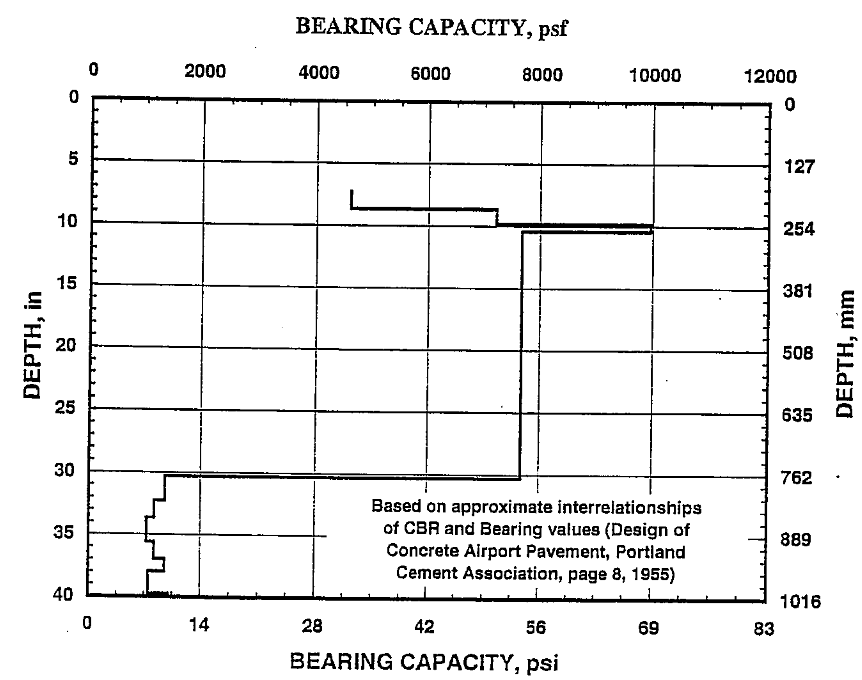
Date: 6-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	185	2
8	220	2
12	250	2
10	265	2
0	770	2
2	820	2
1	855	2
1	905	2
1	940	2
1	965	2
1	1010	2





DCP TEST DATA

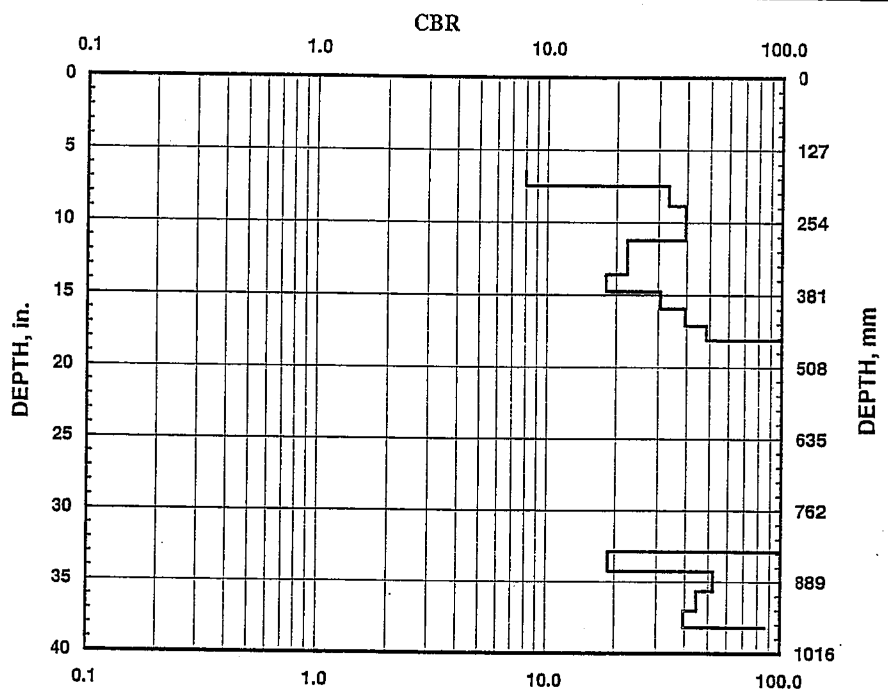
File Name: M362S51+00

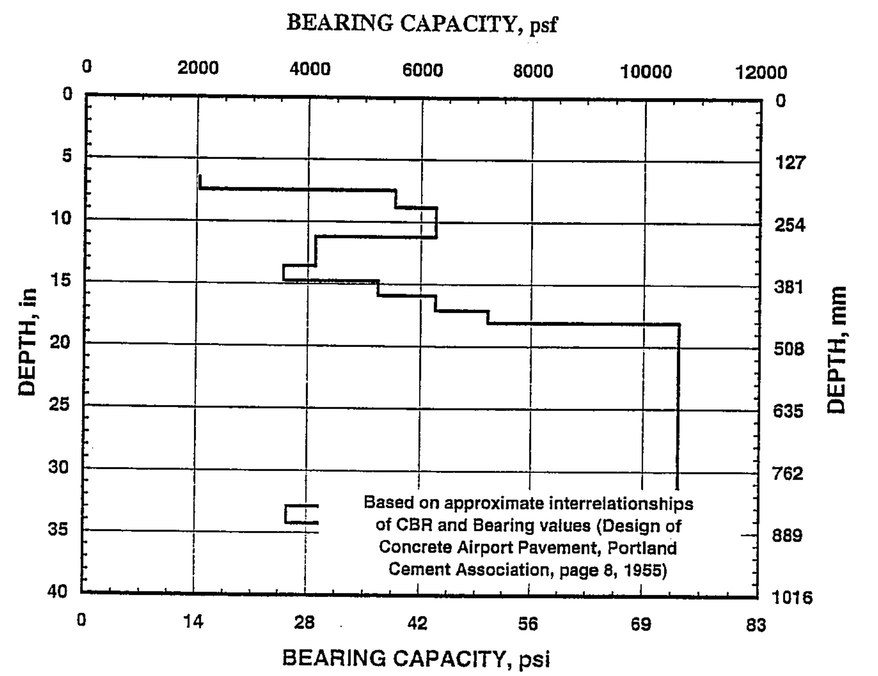
Project: *BLUE RIDGE PARKWAY*
Location: M362 STA 51+00
Date: 6-Aug-03
Soil Type(s): SM

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	165	2
2	190	2
10	225	2
10	255	2
10	285	2
4	305	2
8	345	2
5	375	2
8	405	2
10	435	2
10	460	2
0	835	2
6	870	2
15	905	2
13	940	2
10	970	2





DCP TEST DATA

File Name: M363S10+50

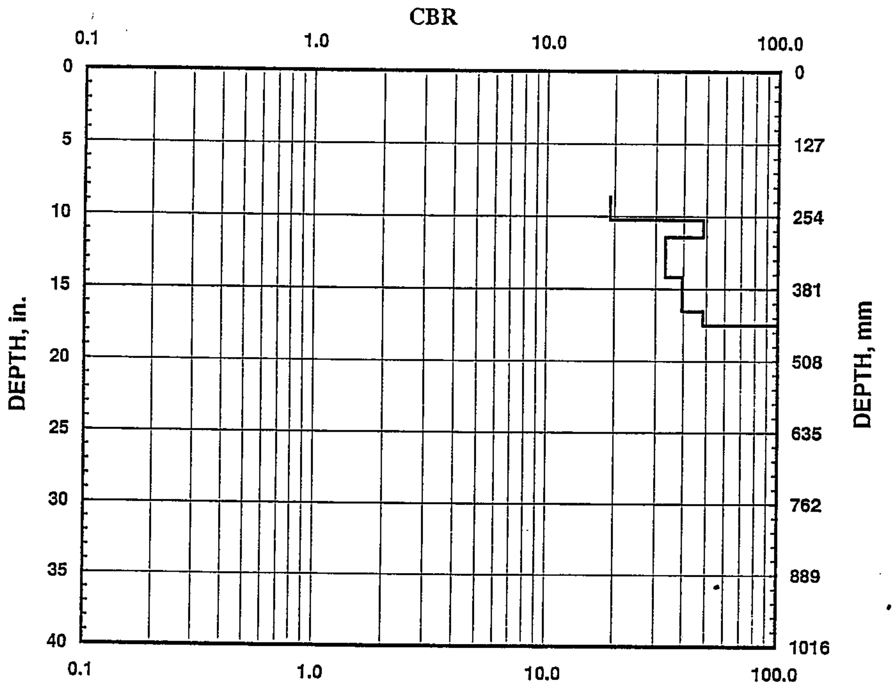
Project: *BLUE RIDGE PARKWAY*
Location: M363 STA 10+50

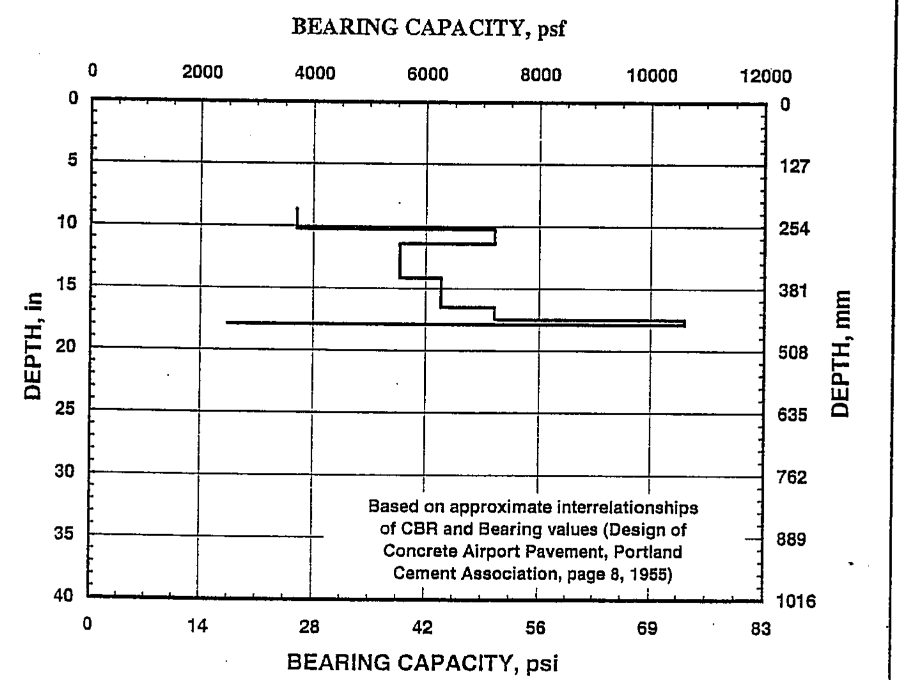
Date: 6-Aug-03
Soil Type(s): SM with Rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	220	2
7	260	2
12	290	2
10	325	2
10	360	2
10	390	2
10	420	2
10	445	2
8	455	2





DCP TEST DATA

File Name: M363S34+00

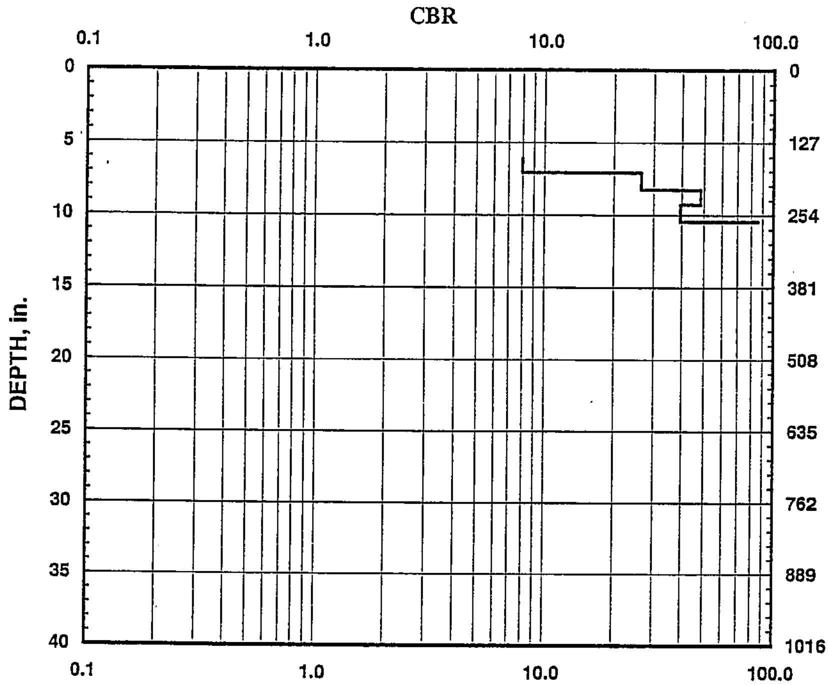
Project: *BLUE RIDGE PARKWAY*
Location: M363 STA 34+00

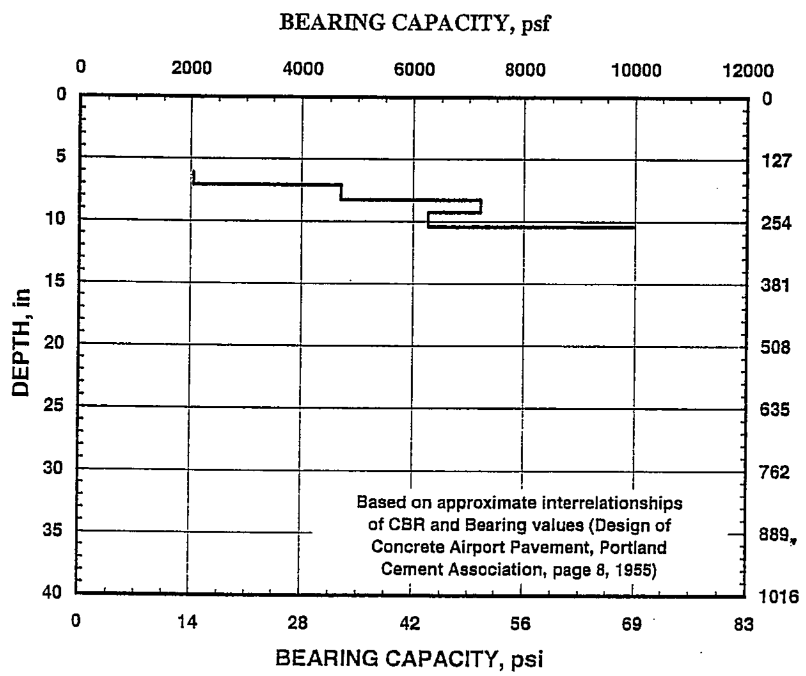
Date: 6-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	155	2
2	180	2
7	210	2
10	235	2
10	265	2





DCP TEST DATA

File Name: M368S12+50

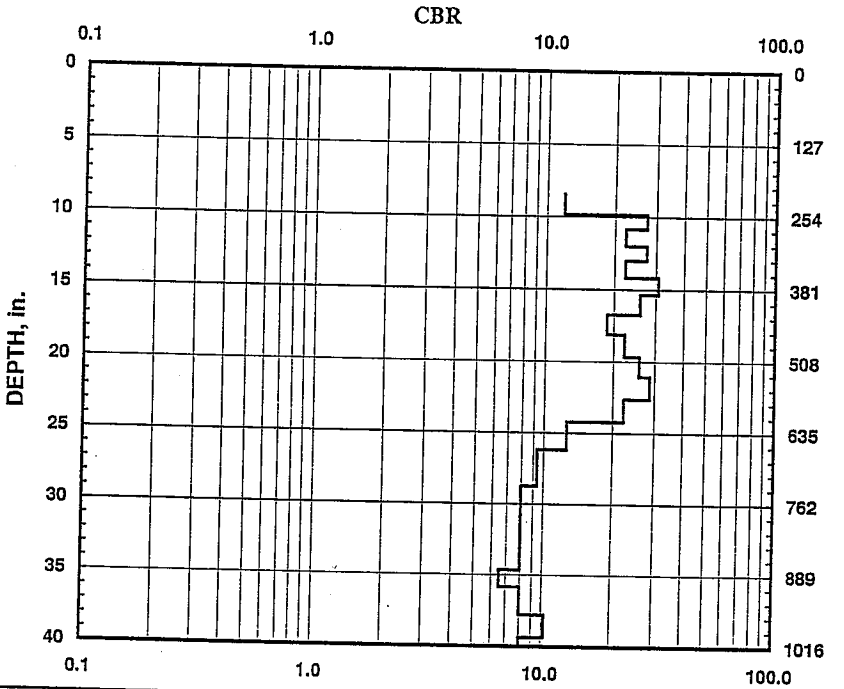
Project: *BLUE RIDGE PARKWAY*
Location: M368 STA 12+50

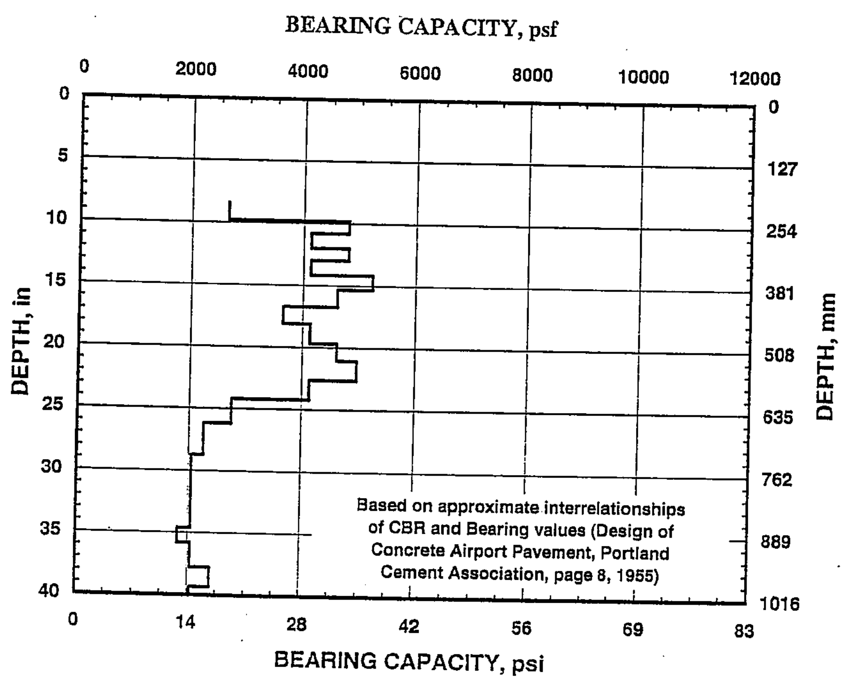
Date: 5-Aug-03
Soil Type(s): SM

Hammer
○ 10.1 lbs.
◉ 17.6 lbs.
○ Both hammers used

Soil Type
○ CH
○ CL
◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	215	1
2	250	1
3	275	1
3	305	1
3	330	1
3	360	1
4	390	1
4	425	1
3	460	1
4	500	1
4	535	1
5	575	1
4	615	1
3	665	1
3	730	1
2	780	1
2	830	1
2	880	1
1	910	1
2	960	1
2	1000	1
2	1050	1





DCP TEST DATA

File Name: M369S4+50

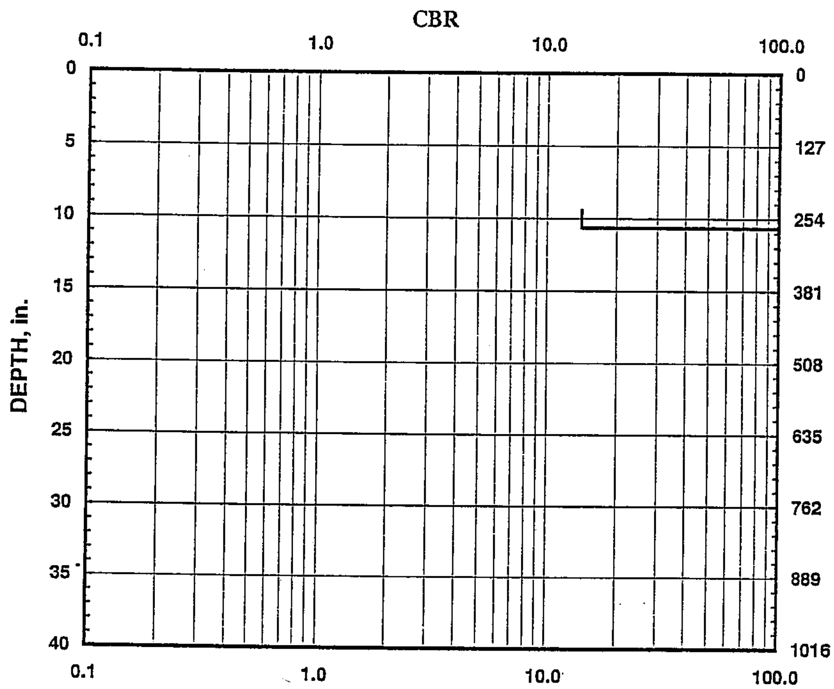
Project: *BLUE RIDGE PARKWAY*
Location: M369 STA 4+50

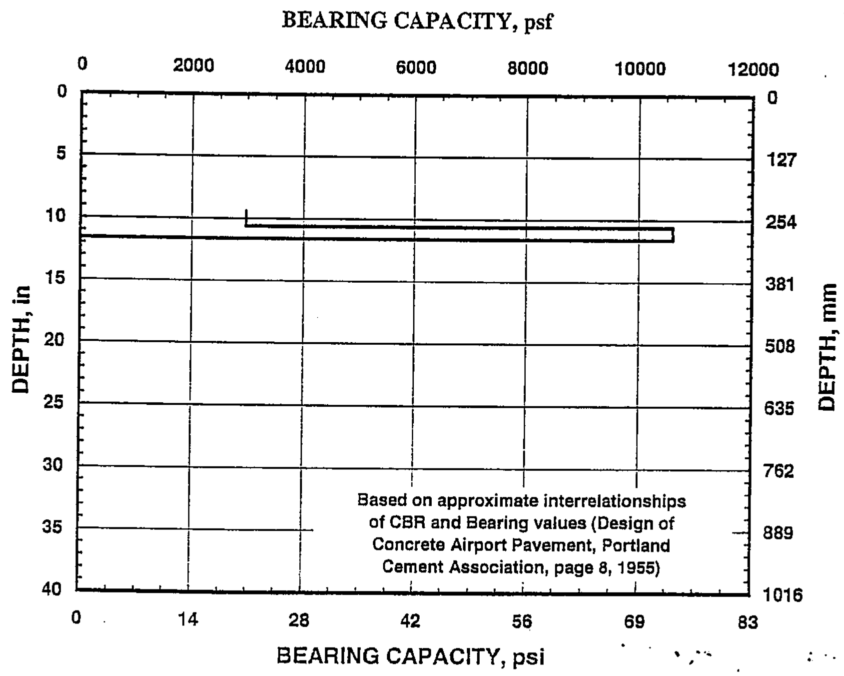
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	240	1
2	270	1
10	295	1
15	310	1





DCP TEST DATA

File Name: M369S14+00

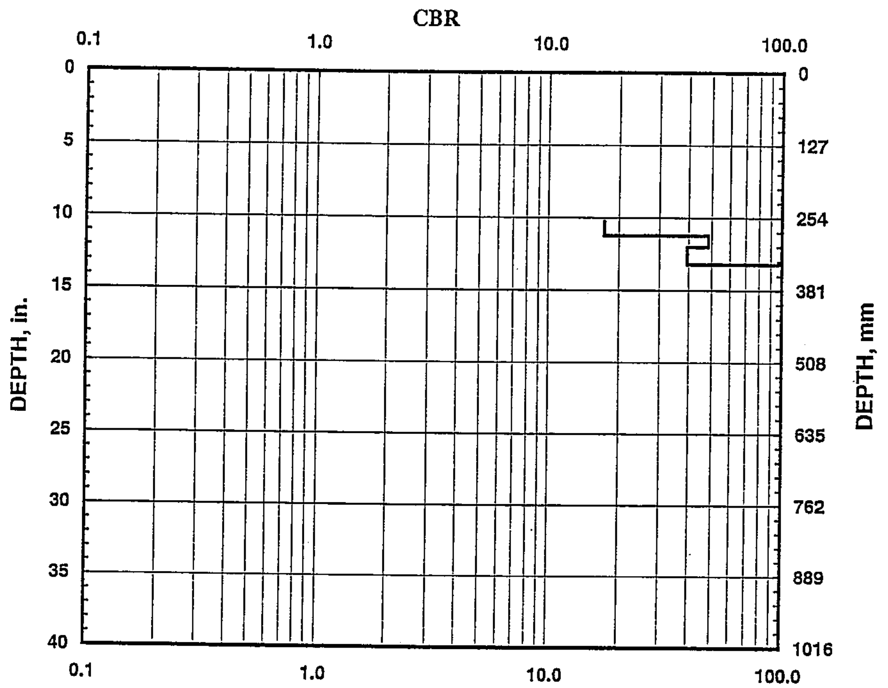
Project: *BLUE RIDGE PARKWAY*
Location: M369 STA 14+00

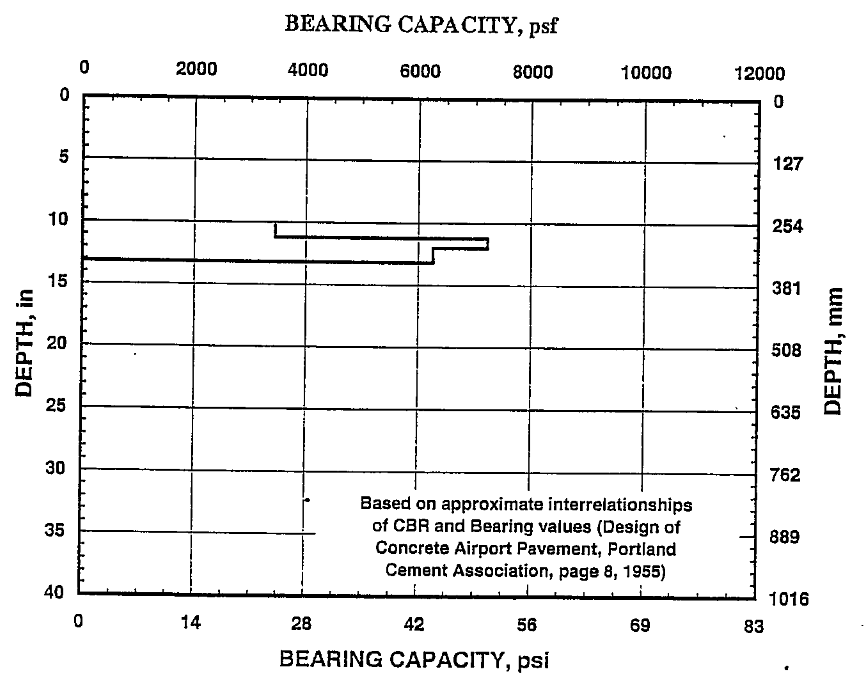
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	260	1
2	285	1
4	305	1
5	335	1
17	350	1





DCP TEST DATA

File Name: M369S39+00

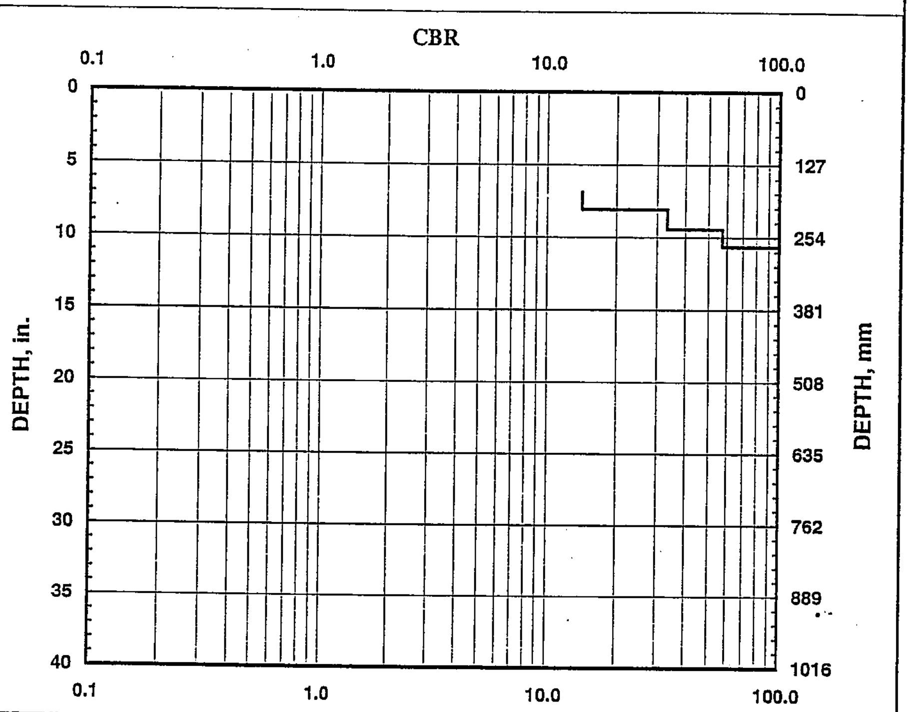
Project: *BLUE RIDGE PARKWAY*
Location: M369 STA 39+00

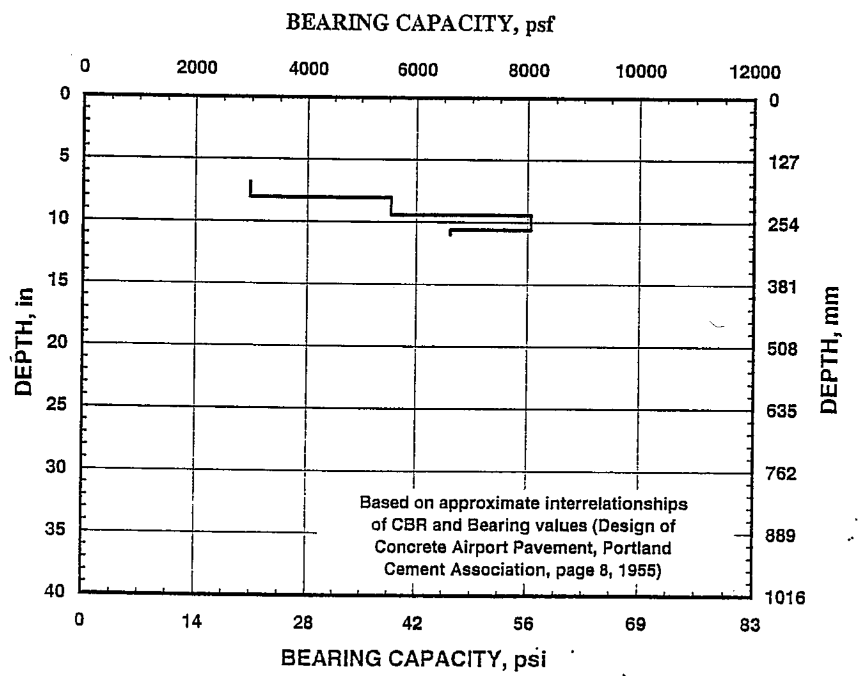
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
○ 10.1 lbs.
◉ 17.6 lbs.
○ Both hammers used

Soil Type
○ CH
○ CL
◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	175	1
2	205	1
5	240	1
7	270	1
7	280	1





DCP TEST DATA

File Name: M370S13+00

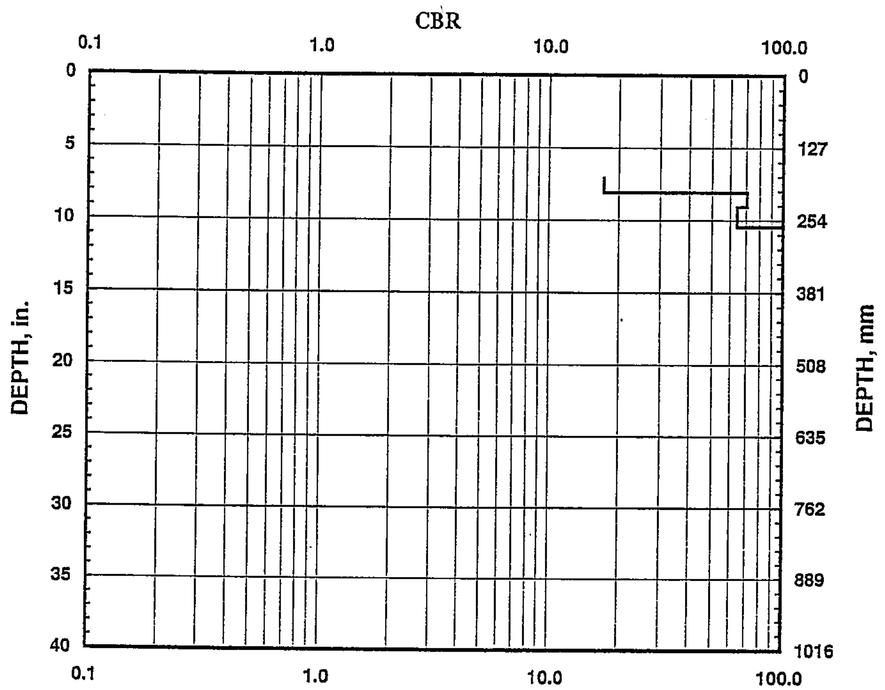
Project: *BLUE RIDGE PARKWAY*
Location: M370 STA 13+00

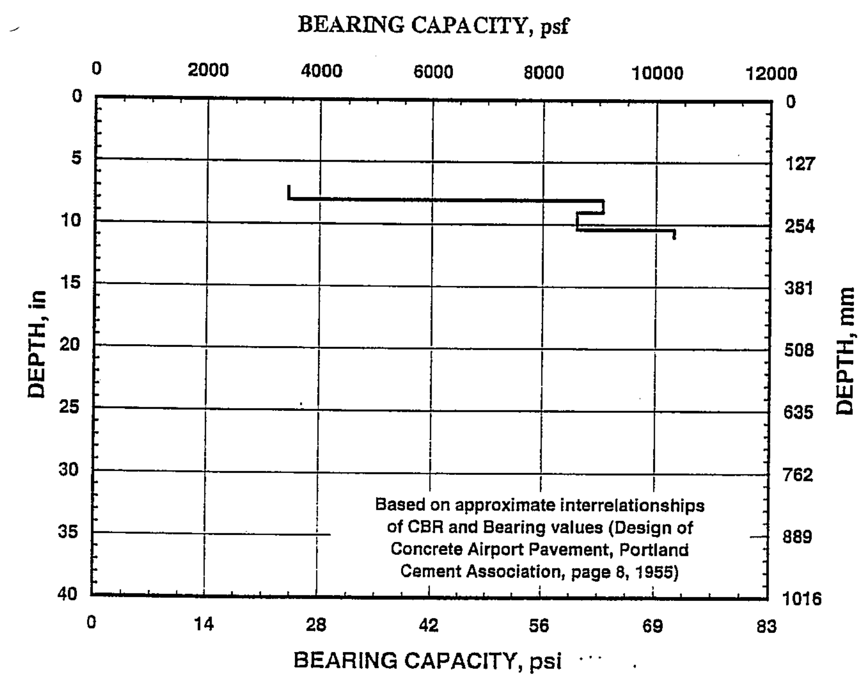
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	180	1
2	205	1
7	230	1
9	265	1
8	280	1





DCP TEST DATA

File Name: M370S38+00

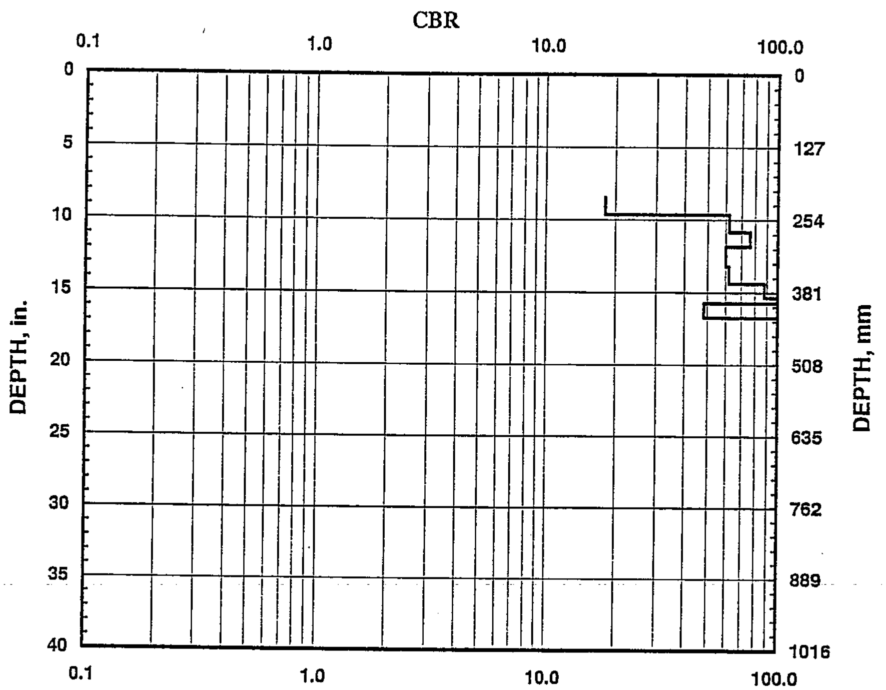
Project: *BLUE RIDGE PARKWAY*
Location: M370 STA 38+00

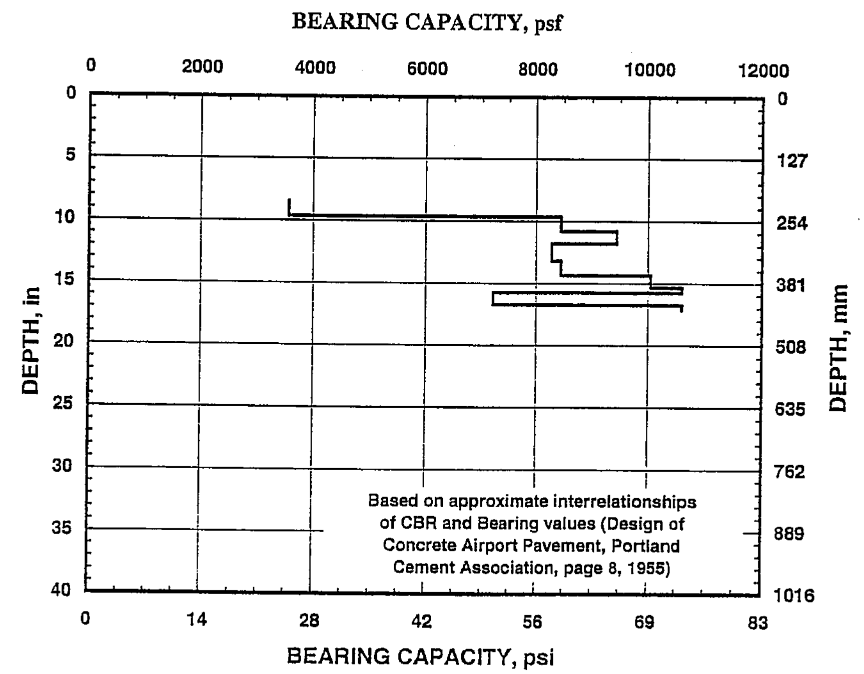
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ○ 17.6 lbs.
- ◉ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	215	2
5	245	2
15	275	2
15	300	2
17	335	2
15	365	2
17	390	2
10	400	2
10	425	1
5	435	1





DCP TEST DATA

File Name: M371S15+00

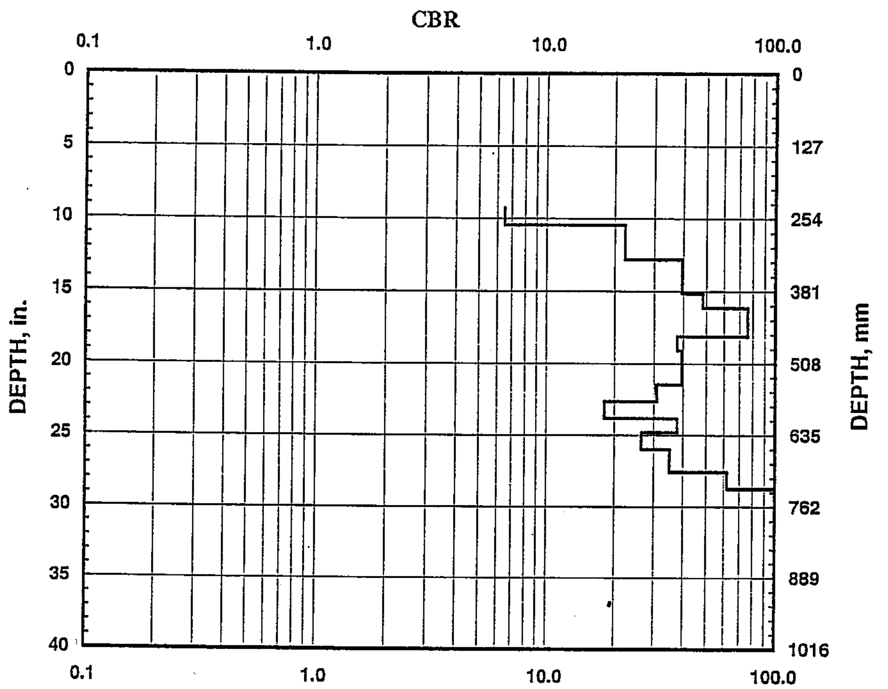
Project: *BLUE RIDGE PARKWAY*
Location: M371 STA 15+00

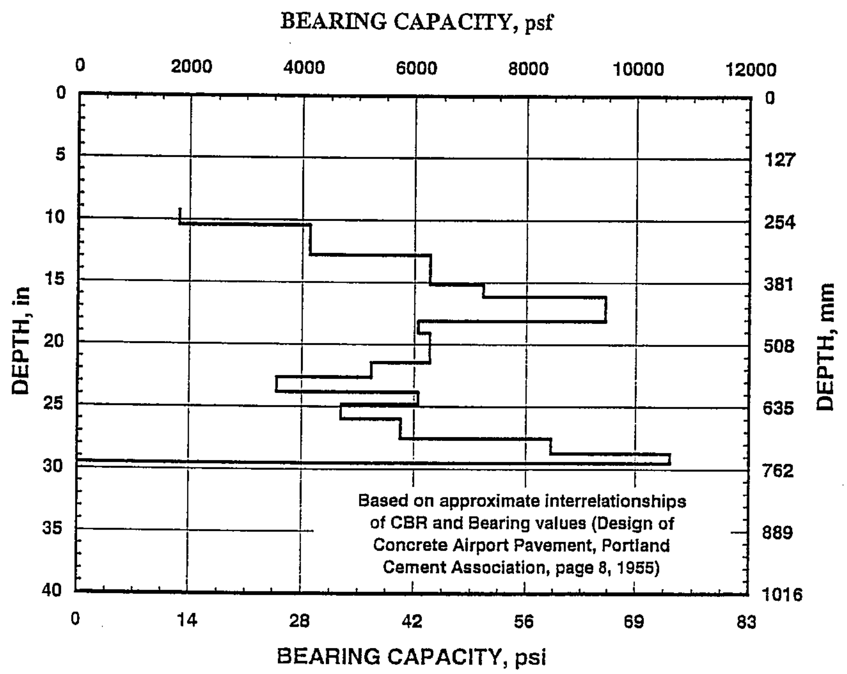
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ◉ 10.1 lbs.
- ○ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	235	2
2	265	2
7	300	2
5	325	2
10	355	2
10	385	2
10	410	2
15	435	2
15	460	2
8	485	2
10	515	2
10	545	2
8	575	2
5	605	2
8	630	2
7	660	2
12	700	2
15	730	2
20	750	2





DCP TEST DATA

File Name: M371S30+00

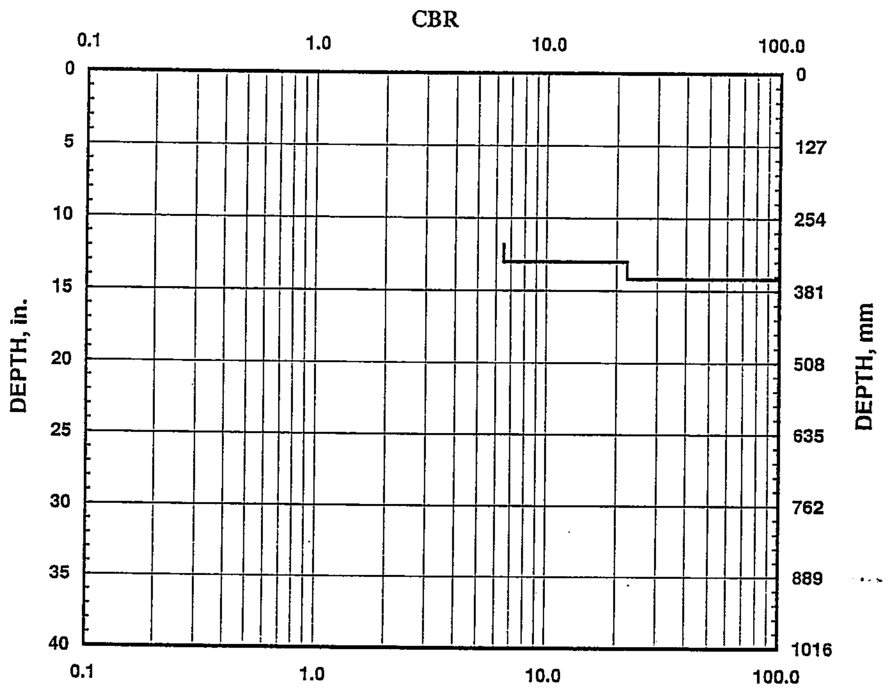
Project: *BLUE RIDGE PARKWAY*
Location: M371 STA 30+00

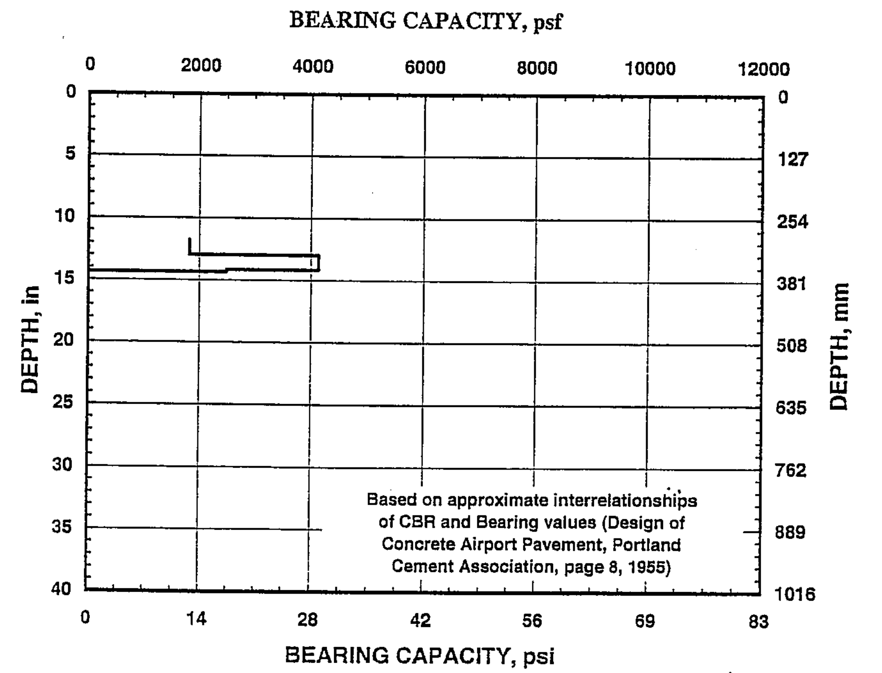
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	300	2
2	330	2
6	360	2
8	365	2





DCP TEST DATA

File Name: M372S14+00

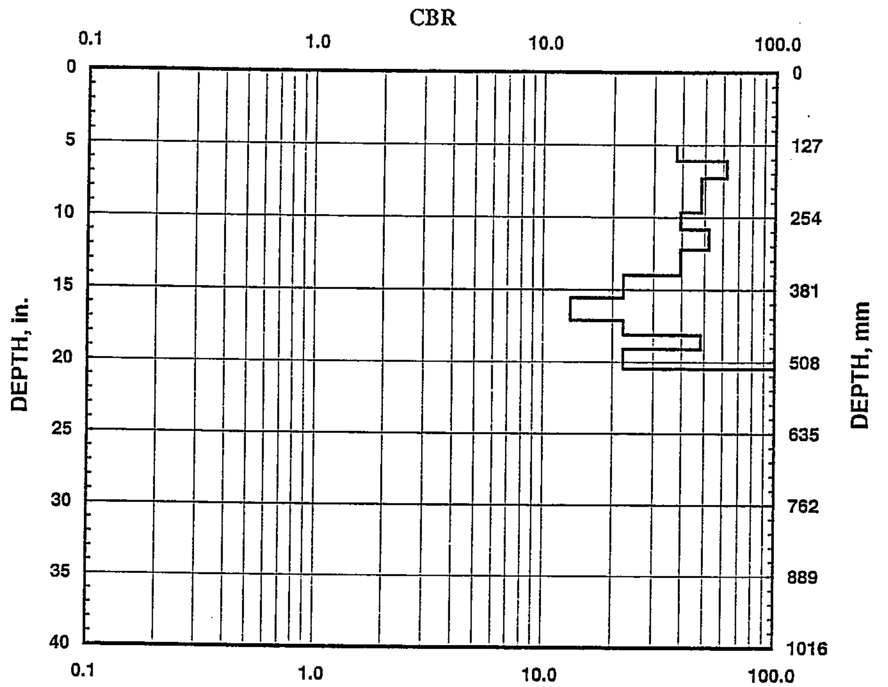
Project: *BLUE RIDGE PARKWAY*
Location: M372 STA 14+00

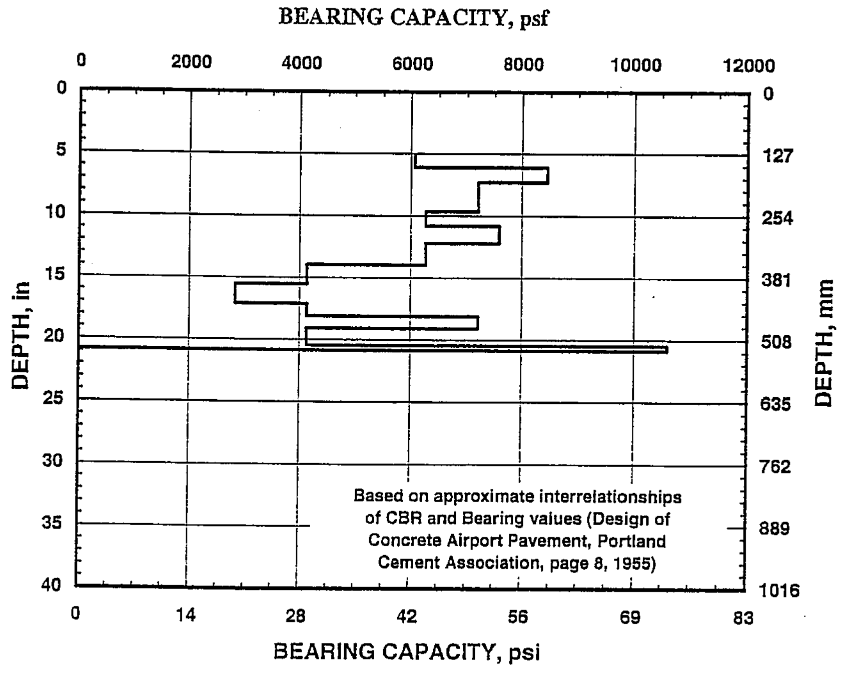
Date: 4-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	130	2
8	155	2
15	185	2
12	215	2
12	245	2
10	275	2
15	310	2
15	355	2
8	395	2
5	435	2
5	460	2
10	485	2
7	520	2
10	530	2





DCP TEST DATA

File Name: M373S17+00

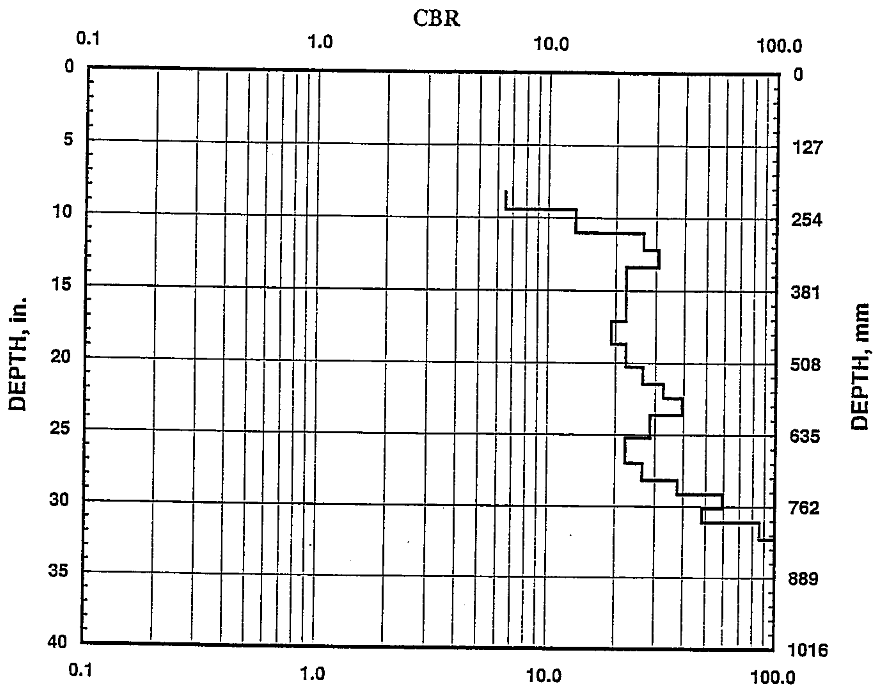
Project: *BLUE RIDGE PARKWAY*
Location: M373 STA 17+00

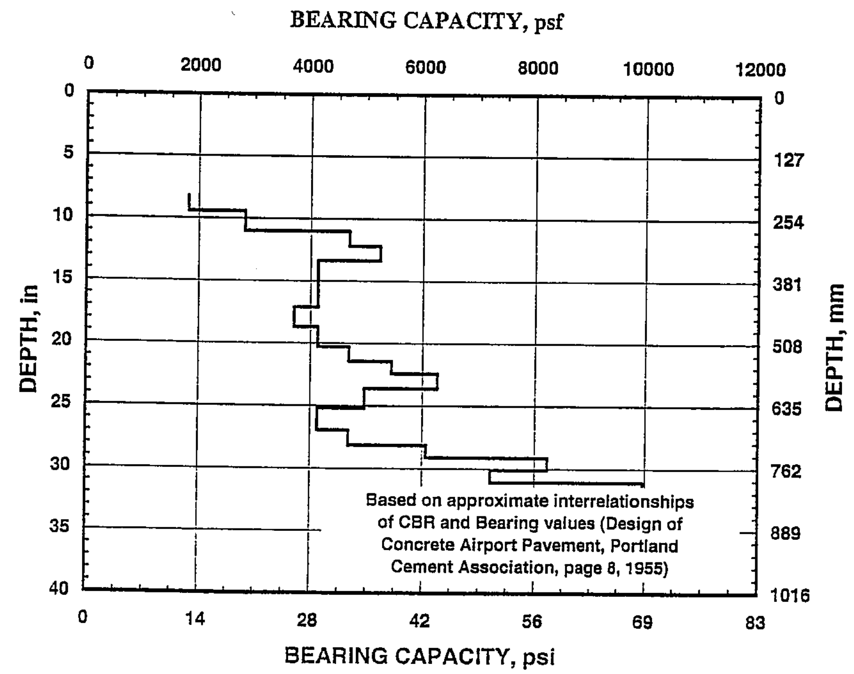
Date: 4-Aug-03
Soil Type(s): SM

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	210	2
2	240	2
5	280	2
7	310	2
8	340	2
8	380	2
6	410	2
5	435	2
7	475	2
8	515	2
7	545	2
7	570	2
10	600	2
10	640	2
9	685	2
7	715	2
8	740	2
12	765	2
10	790	2
20	820	2





DCP TEST DATA

File Name: M373S37+00

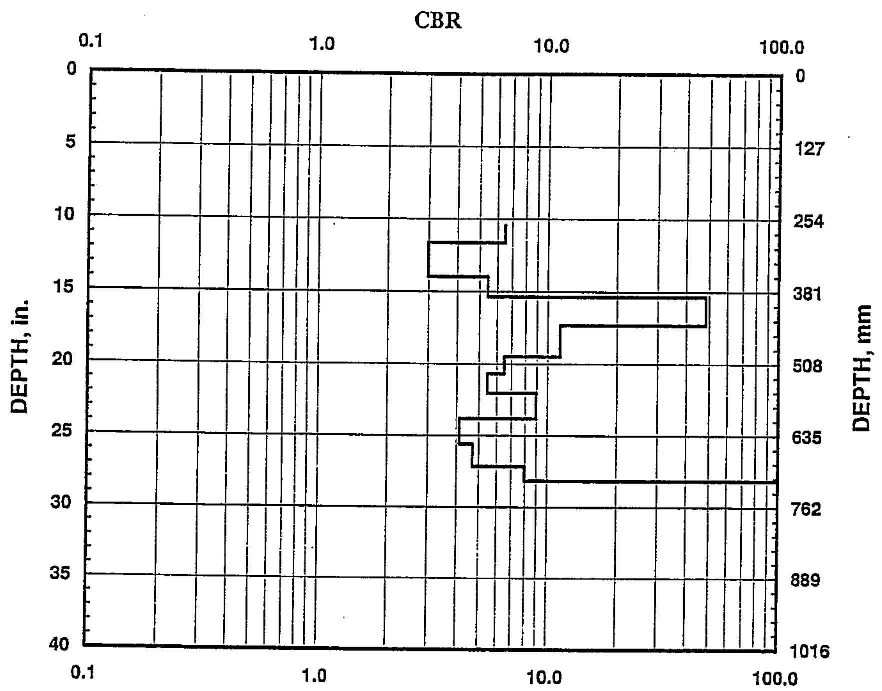
Project: *BLUE RIDGE PARKWAY*
Location: M373 STA 37+00

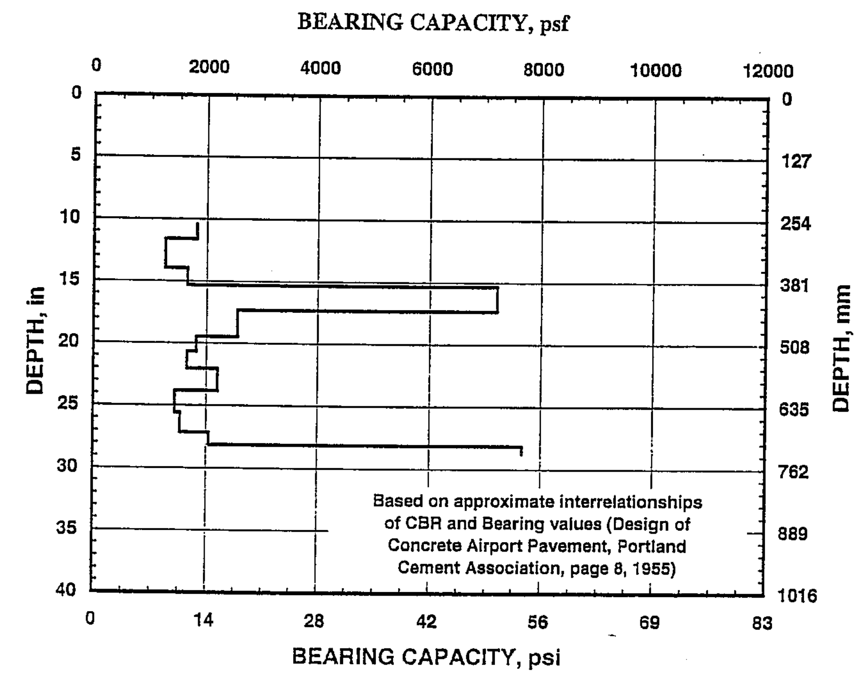
Date: 4-Aug-03
Soil Type(s): ML/SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	265	1
1	295	1
1	355	1
1	390	1
10	440	1
3	495	1
1	525	1
1	560	1
2	605	1
1	650	1
1	690	1
1	715	1
10	730	1





DCP TEST DATA

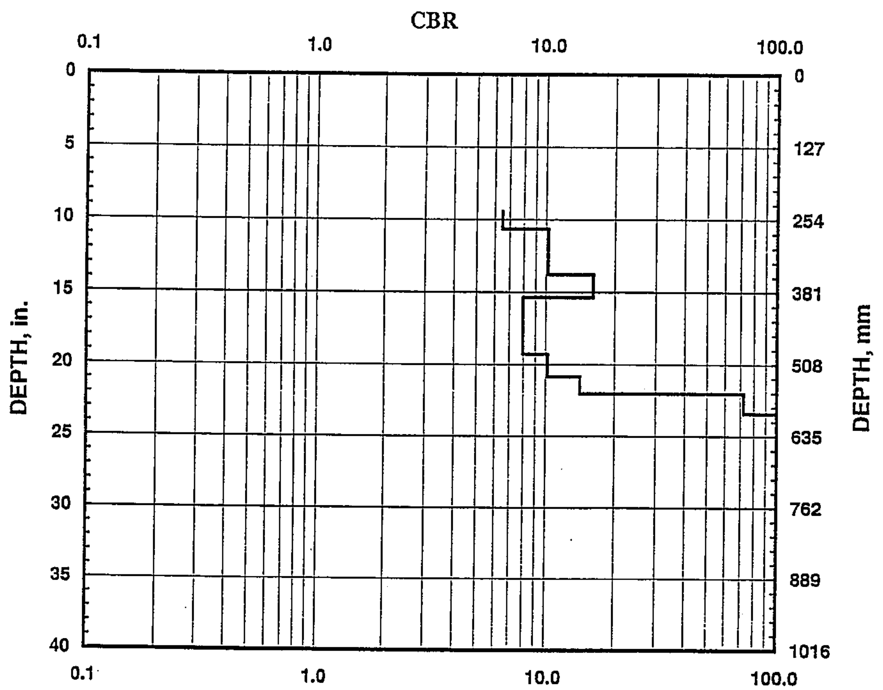
File Name: M374S36+00

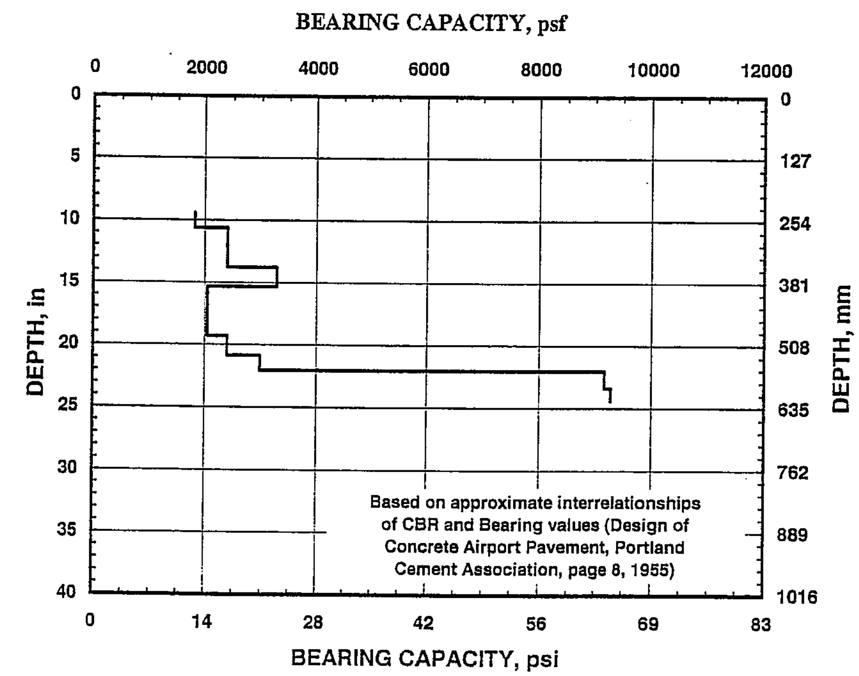
Project: BLUE RIDGE PARKWAY
Location: M374 STA 36+00
Date: 4-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	240	1
1	270	1
2	310	1
2	350	1
3	390	1
2	440	1
2	490	1
2	530	1
2	560	1
10	595	1
15	620	1





DCP TEST DATA

File Name: PA

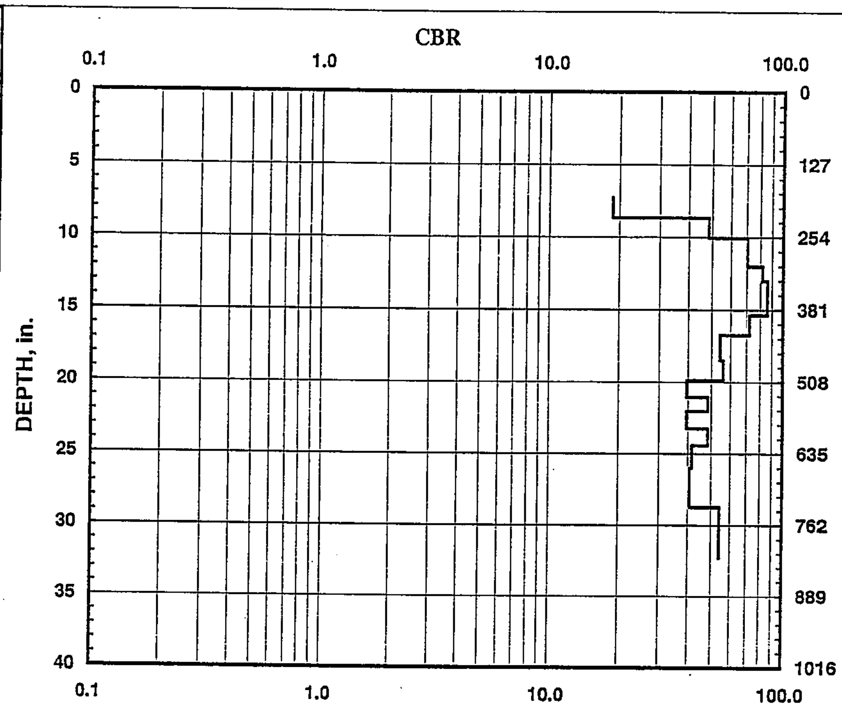
Project: *BLUE RIDGE PARKWAY*
Location: PICNIC AREA PARKING

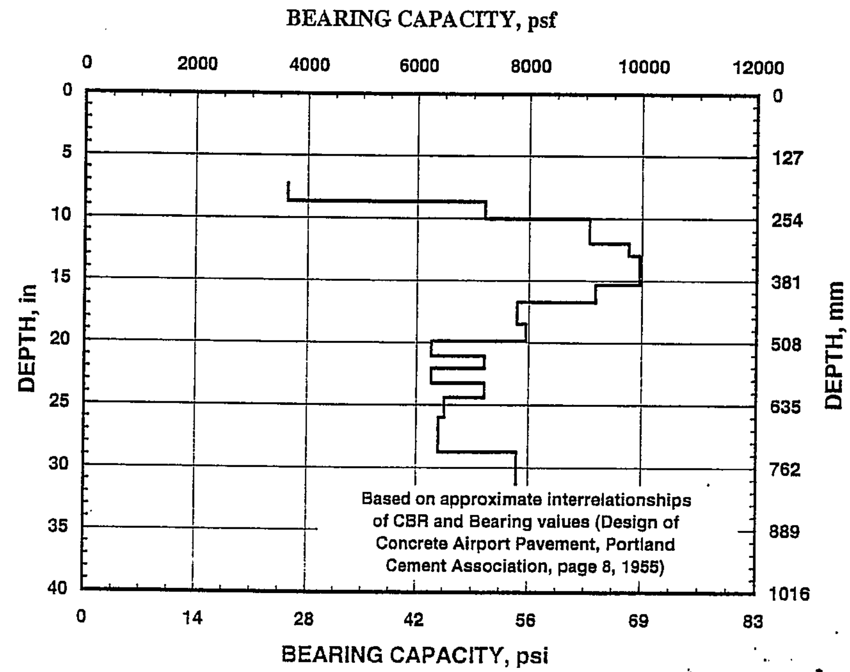
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
○ 10.1 lbs.
◉ 17.6 lbs.
○ Both hammers used

Soil Type
○ CH
○ CL
◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	185	1
3	220	1
7	255	1
7	280	1
7	305	1
8	330	1
10	360	1
10	390	1
10	425	1
10	470	1
8	505	1
5	535	1
5	560	1
5	590	1
6	620	1
7	660	1
6	695	1
6	730	1
10	775	1
10	820	1





DCP TEST DATA

File Name: CD-LOWER

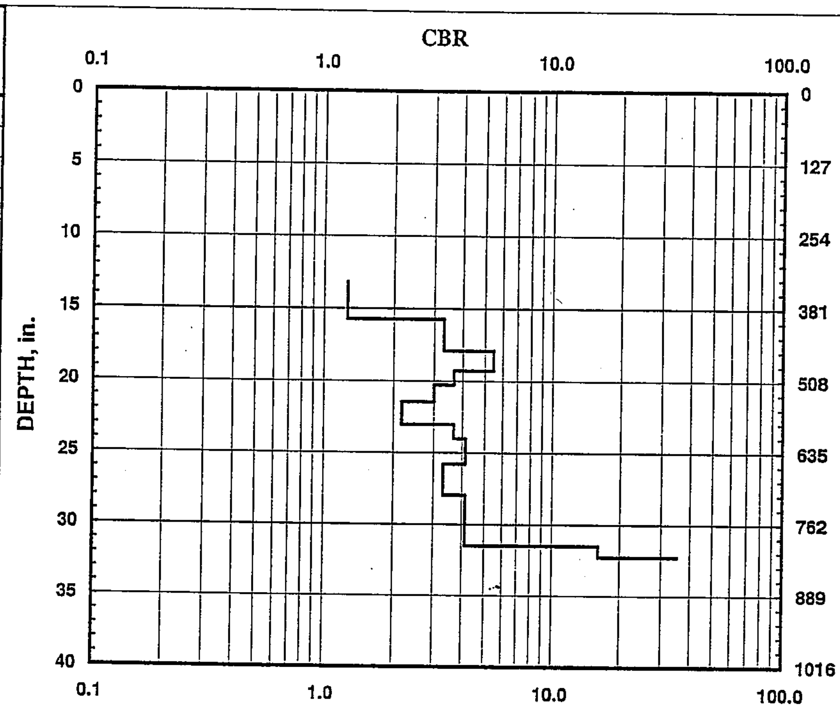
Project: *BLUE RIDGE PARKWAY*
Location: CRAGGY DOME - LOWER

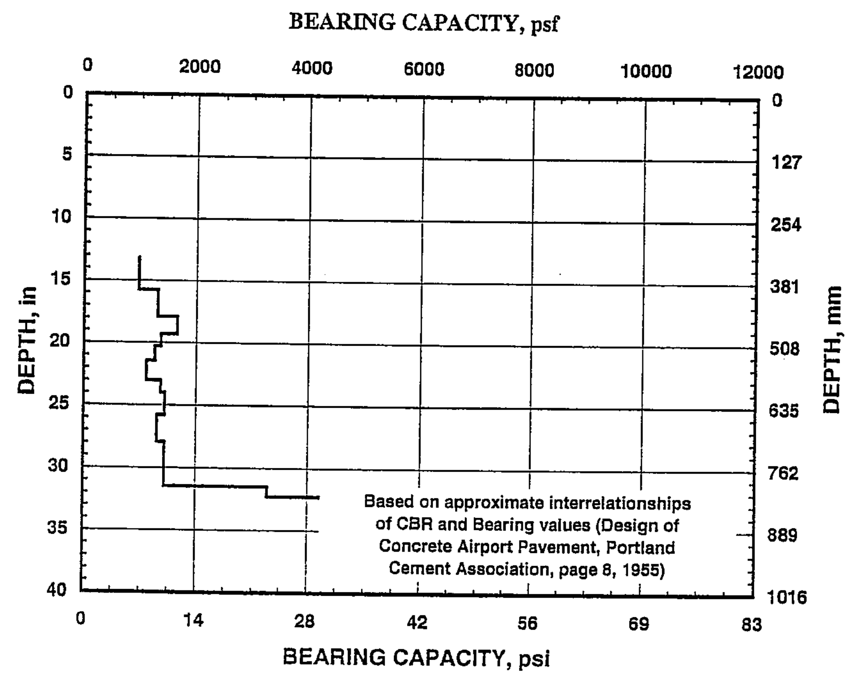
Date: 5-Aug-03
Soil Type(s): SM

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	335	2
1	400	2
2	455	2
2	490	2
1	515	2
1	545	2
1	585	2
1	610	2
2	655	2
2	710	2
2	755	2
2	800	2
3	820	2





DCP TEST DATA

File Name: CD-UPPER

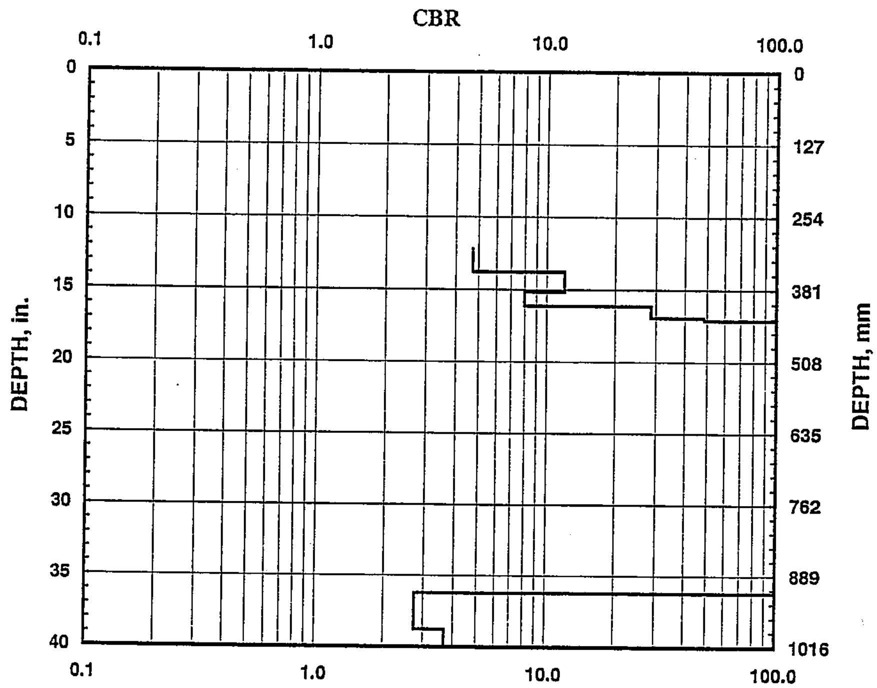
Project: *BLUE RIDGE PARKWAY*
Location: CRAGGY DOME - UPPER

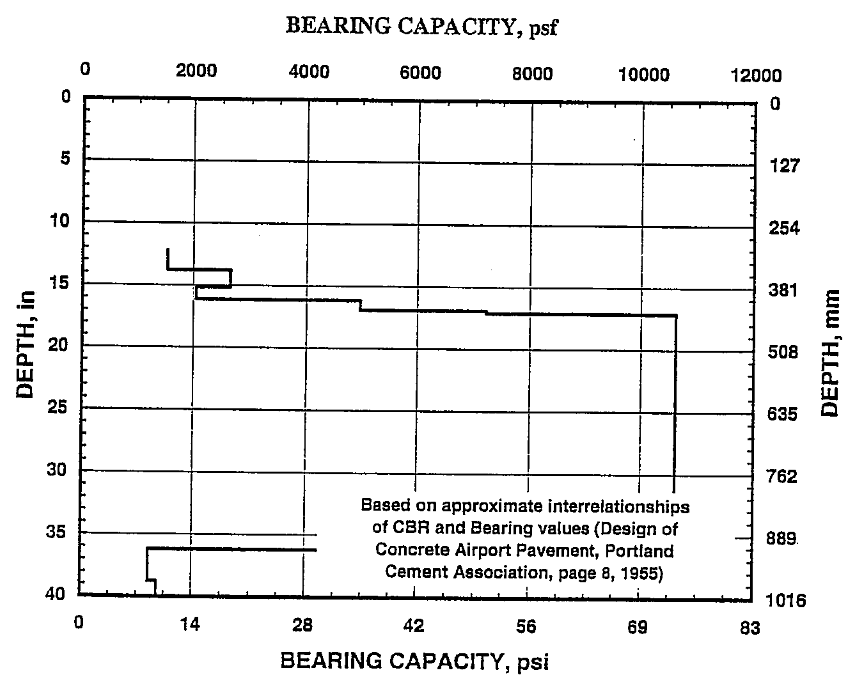
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	310	2
2	350	2
4	385	2
2	410	2
5	430	2
2	435	2
0	920	2
2	985	2
3	1060	2
2	1155	2





Appendix E

DCP Testing

November 5, 2003

ARCADIS G & M, Inc.
1210 Premier Drive, Suite 200
Chattanooga, Tennessee 37421

Project No. 03432

Attention: Mr. Bob Chamlee

Asphalt Pavement Investigation
Blue Ridge Parkway – Section 2P
Milepost 359.8 to 375.3
Asheville, North Carolina

Gentlemen:

Submitted here is the report of our asphalt pavement investigation for the above-referenced project. This field and laboratory testing was authorized by a signed agreement dated July 10, 2003.

General

Plans are being developed by ARCADIS for the Eastern Federal Lands Highway Division of the Federal Highway Administration to rehabilitate a portion of the Blue Ridge Parkway between mileposts 359.8 and 375.3 near Asheville, North Carolina. Burns Cooley Dennis, Inc., was requested by ARCADIS to conduct dynamic cone penetrometer (DCP) testing, laboratory testing of subgrade soils and hot mix asphalt samples and to provide preliminary recommendations for pavement rehabilitation.

The asphalt pavement conditions along this portion of the Blue Ridge Parkway vary from good to very poor. The asphalt roadway has experienced numerous distresses with varying severity levels. The typical pavement distresses include alligator cracking (fatigue), raveling (weathering and oxidation), linear cracking (thermal), block cracking and potholes. Numerous asphalt patches have been placed along the route. This asphalt pavement needs rehabilitation to prevent further deterioration of the flexible pavement structure. Typical pavement conditions at the time of our field investigation (August 2003) are illustrated in Photos 1 through 14.

The field investigation was coordinated and directed by Mr. Scott Manning of ARCADIS. Pavement coring and subgrade drilling and sampling were conducted by S & ME. Asphalt pavement and subgrade conditions along this portion of the Blue Ridge Parkway were explored and evaluated at forty (40) locations selected by ARCADIS.

The specific purposes of our investigation were:

1) to conduct in-situ dynamic cone penetrometer (DCP) testing of subgrade soils at selected boring locations;
2) to evaluate pertinent physical properties of the hot-mix-asphalt (HMA) layers and the subgrade soils encountered by means of visual examination and routine laboratory tests performed on selected representative samples obtained from exploratory coreholes and borings; and
3) to provide guideline recommendations for pavement repair and rehabilitation.

Dynamic Cone Penetrometer (DCP) Testing

A dynamic cone penetrometer (DCP) was utilized to conduct in-situ testing of subgrade materials at twenty-nine (29) selected locations. The DCP testing was conducted to depths ranging between about 1 ft and 3 ft below the asphalt pavement surface. Due to the significant amount of rock fragments in the subgrade materials, the depth of many DCP tests was limited. Based on a correlation developed by the U. S. Army Corps of Engineers, the DCP penetration and the blow count data were converted to California Bearing Ratios (CBRs). A summary of the DCP test results is presented in Table 1. Plots illustrating the computed variation in CBR with depth below the surface for each DCP test are presented in Table 1.

The DCP testing of the subgrade soils yielded CBR values ranging from about 1 (weak) to 100 (very strong). The typical average CBR values range between 10 and 50. The typical in-situ CBR values are high to very high for subgrade soils. These high subgrade strength values have been influenced by the significant amount of rock fragments in the subgrade soils. Low CBR values were determined at three locations.

Subgrade Soil Testing

All of the subgrade soil samples were visually examined in the laboratory by a geotechnical technician and geotechnical engineer. Routine classification tests were performed on thirty-six (36) subgrade materials selected by ARCADIS to verify field classifications and to assist in evaluating the strengths, expansive properties and classifications of the soils encountered in the borings.

The classifications and the plasticity characteristics of the subgrade soils were evaluated by means of visual examination and twelve (12) sets of Atterberg liquid and plastic limit tests. The numerical difference between the liquid limit and plastic limit and the proximity of the in-situ water content to the plastic limit are indicators of the potential for a fine-grained soil (clay) to shrink or swell upon changes in the moisture content or to consolidate under loading. The proximity of the water content to the plastic limit is also an indicator of soil strength. Atterberg limit test results are also useful in estimating and verifying subgrade CBR values. The results of the Atterberg limit tests are presented in Table 2.

To aid in classifying the subgrade materials, sieve analysis tests were conducted on thirty-six (36) samples to determine the percent fines passing the No. 200 sieve. The percentage of minus No. 200 sieve is also presented in Table 2.

Sixty-seven (67) water content tests were performed to evaluate the in-situ moisture conditions and to corroborate field estimates of strength. The results of the moisture content tests are presented in Table 2.

In general, subgrade soils encountered below the asphalt pavement include silts (ML) and silty sands (SM) with rock fragments. The predominant subgrade soil type between mileposts 359 and 375 is silty sand (SM) with an AASHTO classification of A-2-4 (typical design CBR values range between 20 and 30).

Hot-Mix-Asphalt Testing

The thickness of the asphalt layer was determined by measuring the sidewall of the borehole and the extracted field cores. The total thickness of the asphalt layer at each boring location was determined during the drilling operation is presented in Table 2. The thickness of the various asphalt layers at the core locations is presented in Table 3. The asphalt pavement thickness was found to range between 2.5 in. to 7 in. with a typical thickness of 3.5 in. to 4.5 in.

The in-place density and absorption determinations indicate the asphalt pavement compaction levels are marginal with some very low compaction levels. The low compaction levels (high in-place air voids) are generally located between Milepost 365 and 374. The high in-place air void contents have caused the asphalt layers to weather and oxidize at a faster rate than normal. The extreme weathering is one of the primary causes of the significant amount of fatigue cracking. The bulk specific gravity and absorption of each asphalt layer is presented in Table 3.

In order to have sufficient hot-mix-asphalt material to evaluate, the eight (8) cores were grouped to produce three (3) composite samples. Tests were performed on asphalt pavement core samples that had been trimmed and combined to evaluate the in-place HMA mixture characteristics. Tests were conducted to determine the asphalt content and aggregate gradation of the HMA mixture and the absolute viscosity of the recovered asphalt binder. The results of the laboratory tests for the surface course layers are presented in Table 4. The laboratory test results for the binder/base layers are presented in Table 5.

<u>Surface Layer</u>. The test results indicate Group 2 and Group 3 HMA materials are very similar. The asphalt content, extracted aggregate gradation and asphalt binder viscosity for these

groups are significantly different than Group 1. Groups 2 and 3 have a coarser aggregate gradation and a higher asphalt viscosity. HMA materials within the pavement areas represented by Groups 2 and 3 have oxidized and weathered much more than the HMA materials represented by Group 1. The asphalt surface layer within the area represented by Groups 1 and 2 are not suitable for hot-mix-recycling. These surface layers should be removed prior to any pavement rehabilitation.

Binder/Base Layer. The test results indicate the HMA mixture properties are very similar for all three groups. The primary difference between these samples is the asphalt binder's viscosity. Group 1 has a much lower viscosity (softer) than Group 2 and 3.

Recommendations

Based on current pavement conditions, field testing, laboratory evaluations and information provided by ARCADIS, it is our opinion that the following rehabilitation procedures be considered to rehabilitate the Blue Ridge Parkway between Mileposts 359 and 375.

1) Mill and Overlay

- Repair structurally distressed areas
- Mill 2 in. of existing asphalt layer
- Place 3 in. of asphalt surface course layer

2) Reconstruction

- Option 1

    - Remove existing asphalt layers
    - Scarify and compact subgrade soils (minimum 12 in.)
    - Place 8 in. crushed stone base layer
    - Place 4 in. asphalt surface layer (two layers)

- Option 2

    - Remove existing asphalt layers
    - Cold mix recycle existing asphalt layer and subgrade (minimum 8 in.)
    - Place 3 in. of asphalt binder layer
    - Place 2 in. of asphalt surface layer

These rehabilitation options should be selected based on pavement surface conditions and structural integrity. Areas that exhibit a significant amount of fatigue cracking should be reconstructed. Sections of the roadway that are generally in fair to good condition should be milled and overlaid with a minimum 3-in. overlay.

The pavement thickness recommendations presented above should be considered guideline recommendations based on experience with previous Eastern Federal Lands Highway Division projects. A detailed pavement design based on anticipated traffic volumes and intensities is beyond the scope of this investigation. We understand that ERES Consultants is preparing a detailed pavement design for the actual traffic loadings and appropriate design parameters for the subgrade soils and asphalt pavement layers.

Report Limitations

The conclusions and recommendations discussed in this report are based on the conditions as they existed at the time of our field investigation and further on the assumption that the borings were representative of the pavement and subsurface conditions throughout the pavement area investigated. It should be noted that actual pavement and subsurface conditions between and beyond the boring locations might differ from those encountered at those locations.

This report has been prepared for ARCADIS for specific application to the geotechnical-related aspects for pavement improvements to the Blue Ridge Parkway north of Ashville, North Carolina. The only warranty made by us in connection with the services provided is we have used the degree of care and skill ordinarily exercised under similar conditions by reportable members of our profession practicing in the same or similar locality. No other warranty, expressed or implied, is made or intended.

We appreciate the opportunity to be of service. If you have any questions concerning this letter or need additional services, please do not hesitate to call.

Very truly yours,

BURNS COOLEY DENNIS, INC.

R. C. Ahlrich, Ph.D., P.E.

S. Caleb Douglas, P.E.

RCA/khb
Copies Submitted: (3)

PHOTOS

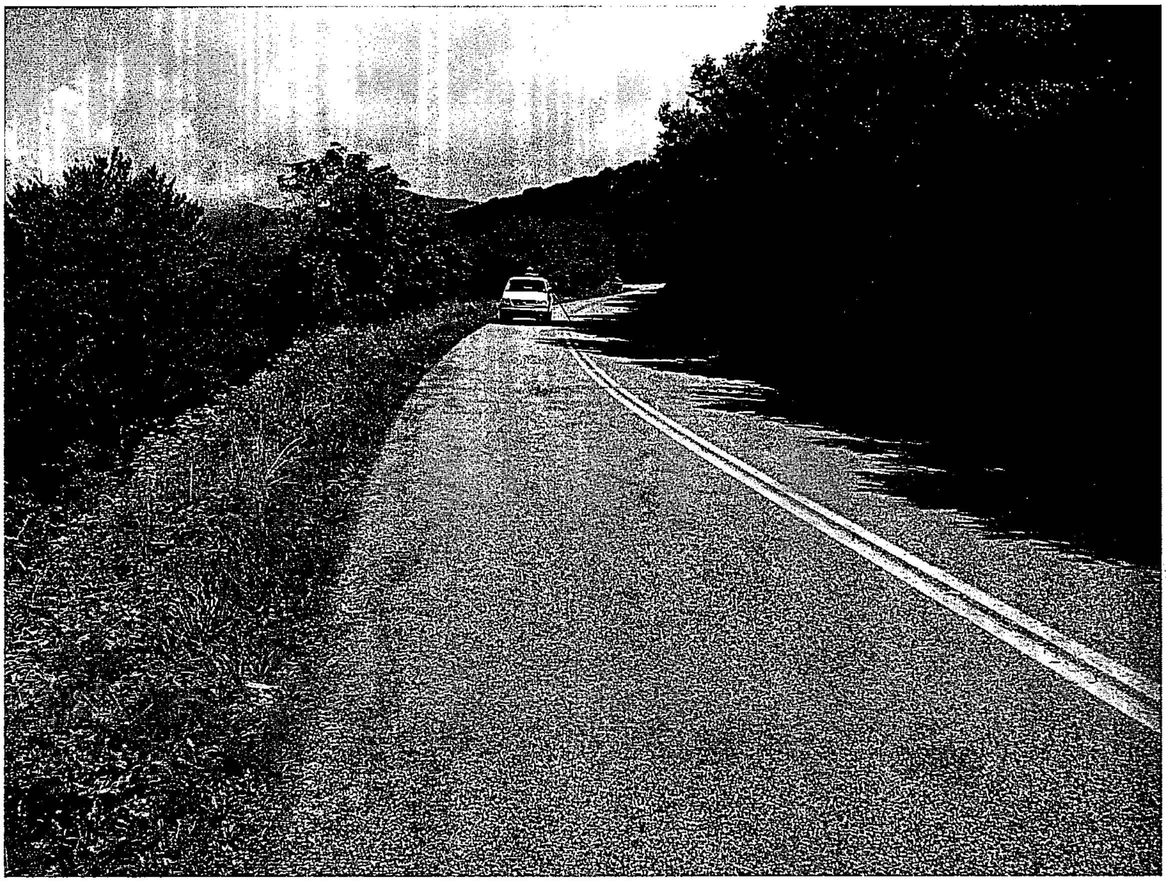


Photo 1. Blue Ridge Parkway M362 Station 10+00
No Distress

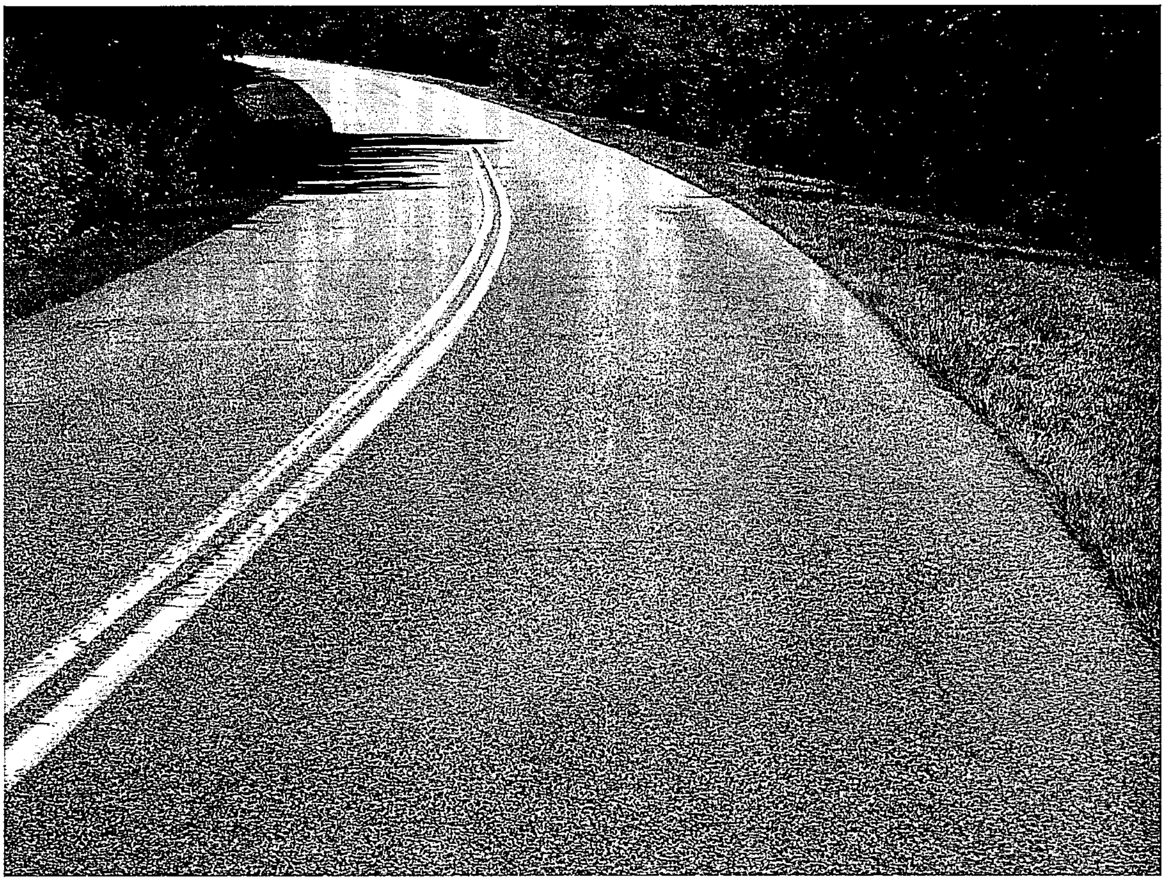


Photo 2. Blue Ridge Parkway M366 Station 41+00
Wheelpath Fatigue Cracking (Low Severity)

Photo 3. Blue Ridge Parkway M366 Station 41+00
Fatigue Cracking and Potholes (High Severity)

Photo 4. Blue Ridge Parkway M367 Station 47+00
Wheelpath Fatigue Cracking

Photo 5. Blue Ridge Parkway M372 Station 49+00
Minimal Cracking

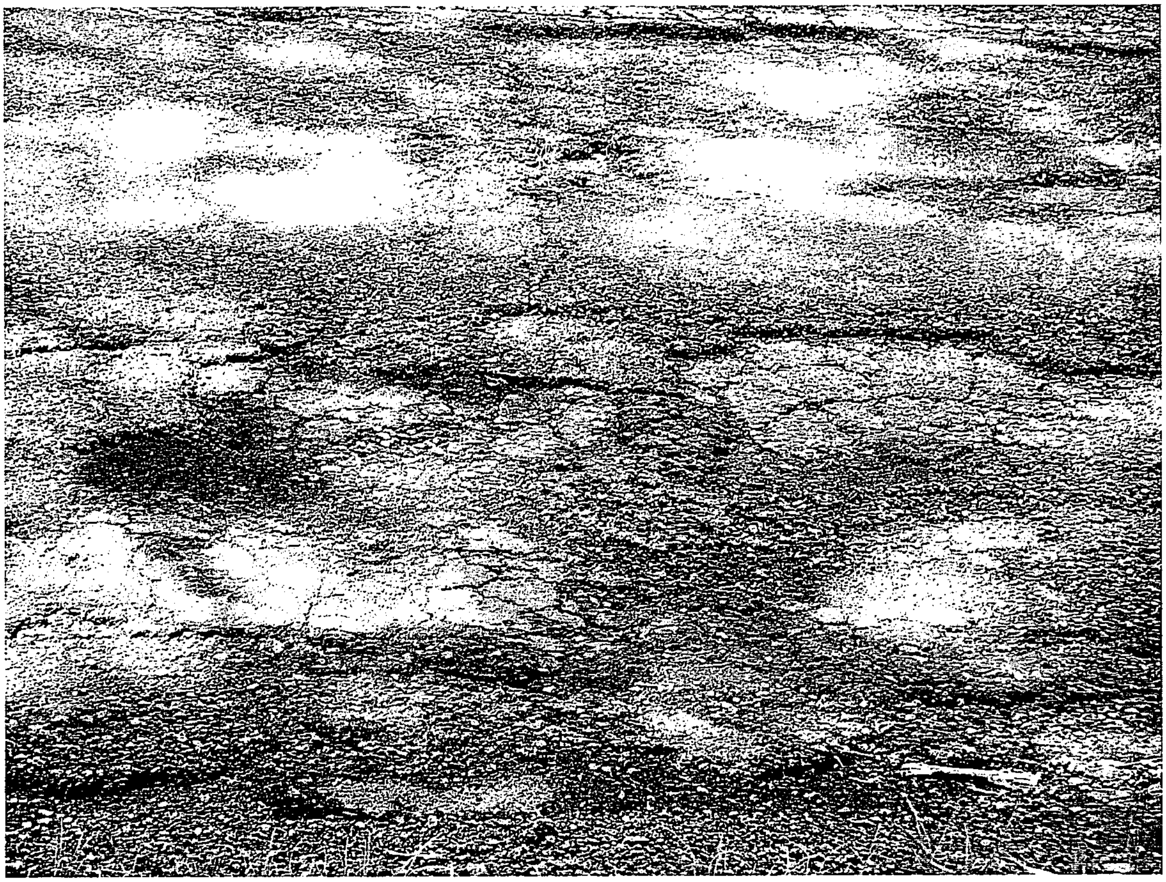


Photo 6. Blue Ridge Parkway M373 Station 45+25
Fatigue Cracking and Raveling (High Severity)

Photo 7. Blue Ridge Parkway M374 Station 1+00
Wheelpath Fatigue Cracking

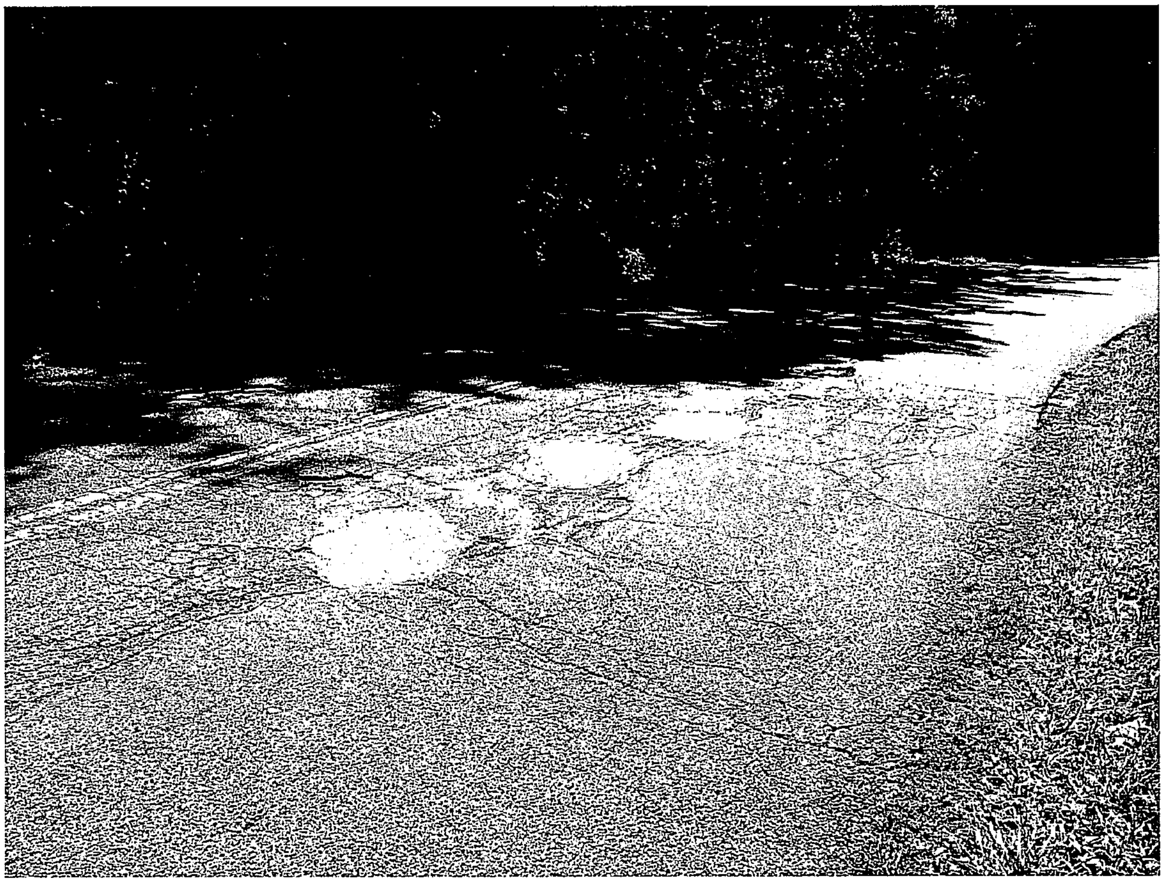


Photo 8. Blue Ridge Parkway M374 Station 2+75
Fatigue Cracking with Asphalt Patch (Medium Severity)

Photo 9. Craggy Gardens Visitor Center
Thermal Cracking

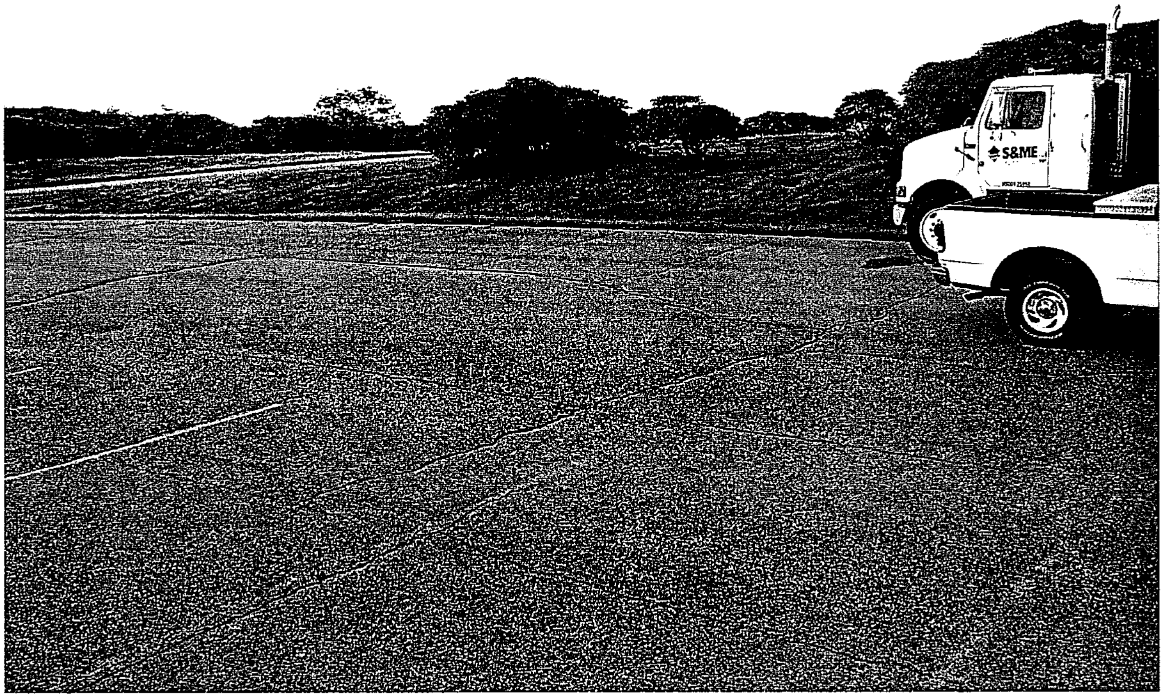


Photo 10. Craggy Dome Lower Tier Parking
Thermal Cracking

Photo 11. Blue Ridge Parkway Near Craggy Dome
Thermal Cracking

Photo 12. Blue Ridge Parkway
Typical High Severity Raveling

Photo 13. Blue Ridge Parkway
Typical Fatigue Cracking with Asphalt Patch

Photo 14. Blue Ridge Parkway
Typical Fatigue Cracking and Raveling in Wheelpath

DYNAMIC CONE PENETROMETER
TEST RESULTS

TABLE 1
SUMMARY OF DCP TEST RESULTS - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Location	Depth Interval (in) Below Pavement Surface	Average CBR Values
MM 359 Station 41 + 50	10 - 15 15 - 20 20 - 32	40 6 3
MM 360 Station 50 + 00	10 - 16 @ 16	20 100+
MM 362 Station 10 + 50	9 - 12 @ 12 24 - 29 (*) 29 - 34 (*)	30 100+ 1.5 8
MM 362 Station 23 + 00	8 - 10 @ 10 30 - 40 (*)	50 100+ 2.5
MM 362 Station 51 + 00	7 - 18 @ 18 34 - 38 (*)	30 100+ 40
MM 363 Station 10+50	10 - 17 @ 17	35 100+
MM 363 Station 34+00	7 - 11 @ 11	35 100+
MM 367 Station 21+50	@ 10 @ 12	80 100+
MM 367 Station 39+00	5 - 10 10 - 15 15 - 23 23 - 29 @ 29	40 25 10 40 100+
MM 368 Station 12+50	10 - 24 24 - 40	25 8

(*) Note: Additional DCP testing conducted after split-spoon sampling

TABLE 1 (continued)
SUMMARY OF DCP TEST RESULTS - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Location	Depth Interval (in) Below Pavement Surface	Average CBR Values
MM 368 Station 38+00	14 - 17 @ 17	40 100+
MM 369 Station 4+50	@ 11	100+
MM 369 Station 14+00	11 - 14 @ 14	40 100+
MM 369 Station 39+00	8 - 11 @ 11	35 100+
MM 370 Station 13+00	8 - 11 @ 11	70 100+
MM 370 Station 38+00	10 - 16 @ 16	70 100+
MM 371 Station 15+00	10 - 28 @ 28	30 100+
MM 371 Station 30+00	@ 12 @ 14	20 100+
MM 372 Station 14+00	6 - 14 14 - 21 @ 21	35 20 100+
MM 373 Station 17+00	9 - 26 26 - 33	20 50
MM 373 Station 37+00	11 - 15 15 - 28 @ 28	4 6 100+
MM 374 Station 36+00	11 - 22 @ 24	10 100+

TABLE 1 (continued)
SUMMARY OF DCP TEST RESULTS - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Location	Depth Interval (in.) Below Pavement Surface	Average CBR Value
MM 375 Station 0+00	@ 8 12 - 14 (*) @ 14 (*)	100+ 40 100+
Picnic Area Parking	8 - 32	50
Picnic Access Road Station 20+50	4 - 10 @ 10	25 100+
Picnic Access Road Station 36+80	6 - 12 12 - 40	4 1
Craggy Dome Lower	16 - 32	3
Craggy Dome Upper	14 - 16 @ 17	10 100+

(*) Note: Additional DCP testing conducted after auger sampling

DCP TEST DATA

File Name: M359S41+50

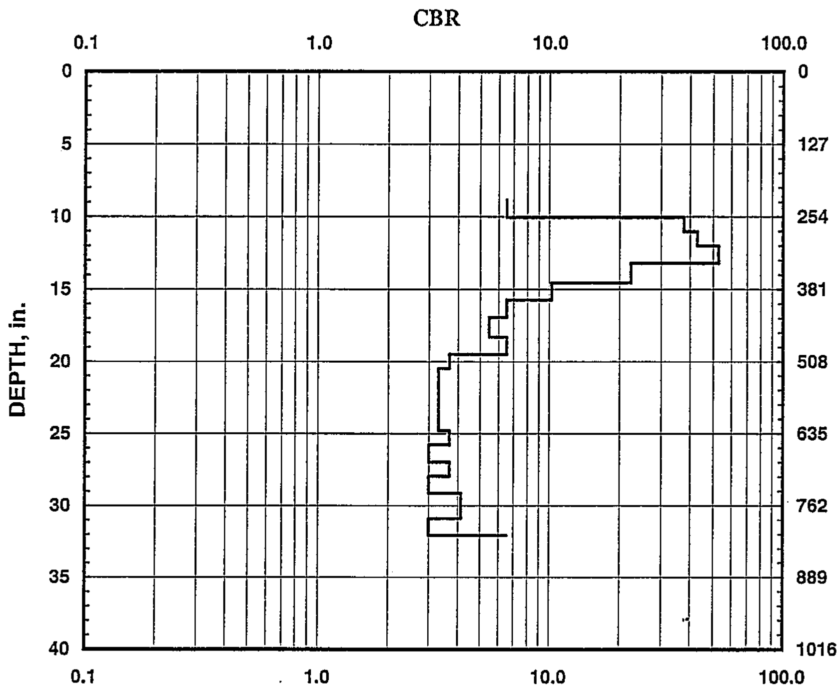
Project: *BLUE RIDGE PARKWAY*
Location: M359 STA 41+50

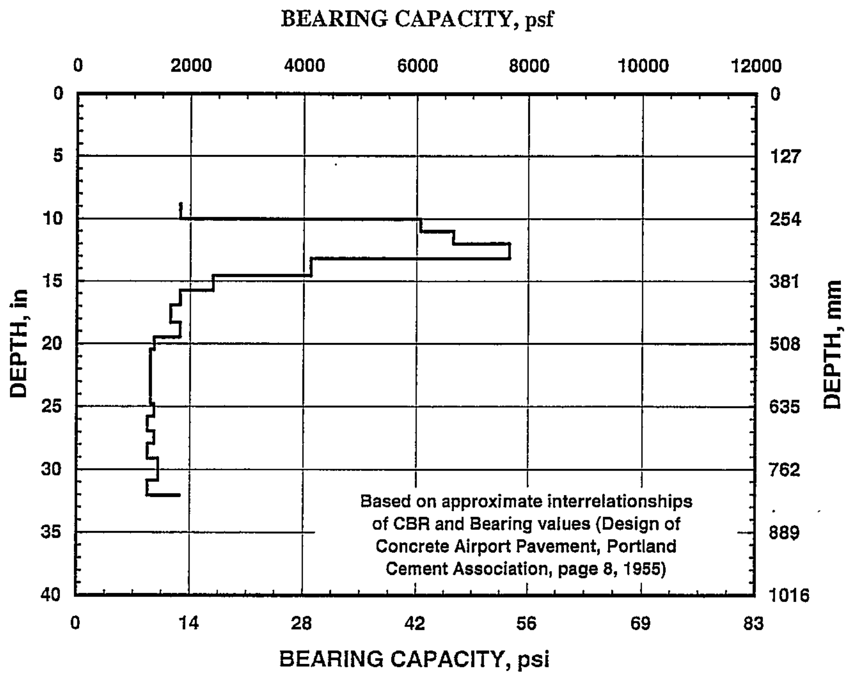
Date: 6-Aug-03
Soil Type(s): ML with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	225	2
2	255	2
8	280	2
9	305	2
13	335	2
7	370	2
3	400	2
2	430	2
2	465	2
2	495	2
1	520	2
2	575	2
2	630	2
1	655	2
1	685	2
1	710	2
1	740	2
2	785	2
1	815	2





DCP TEST DATA

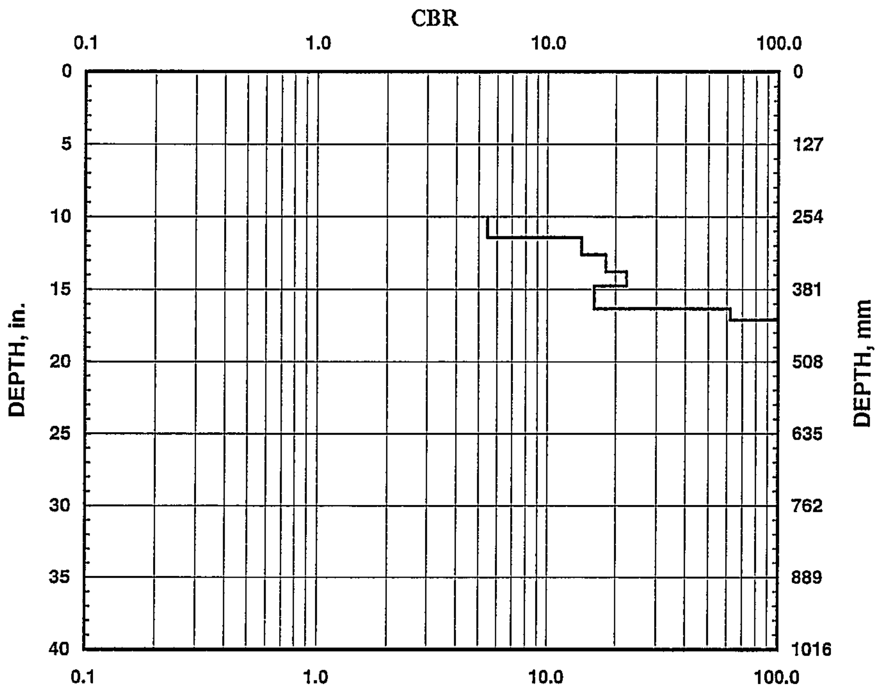
File Name: M360S50+00

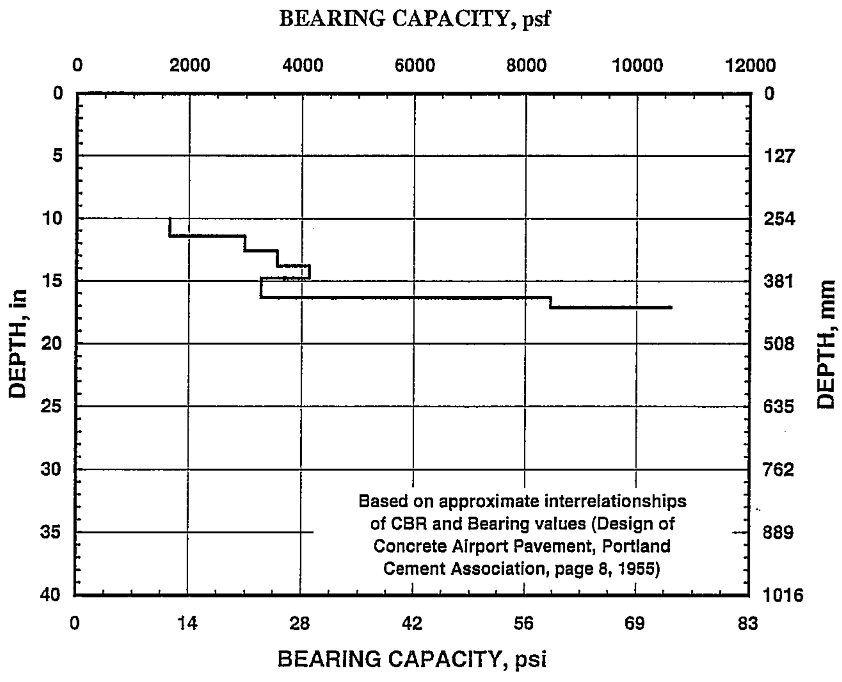
Project: *BLUE RIDGE PARKWAY*
Date: 6-Aug-03
Location: M360 STA 50+00
Soil Type(s): ML with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	255	2
2	290	2
4	320	2
5	350	2
5	375	2
6	415	2
10	435	2





DCP TEST DATA

File Name: M361S51+00

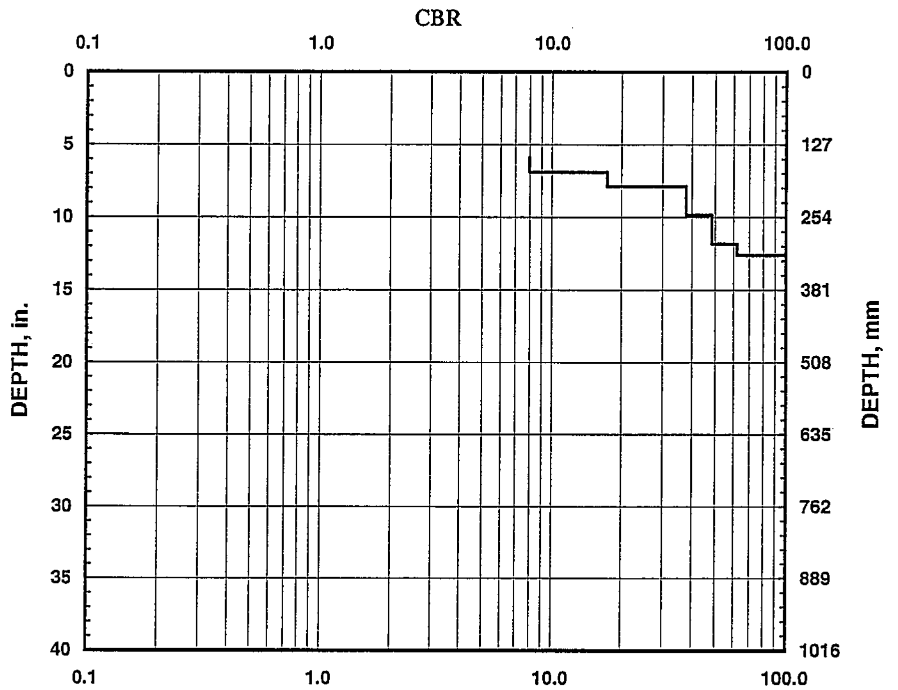
Project: *BLUE RIDGE PARKWAY*
Location: M361 STA 51+00

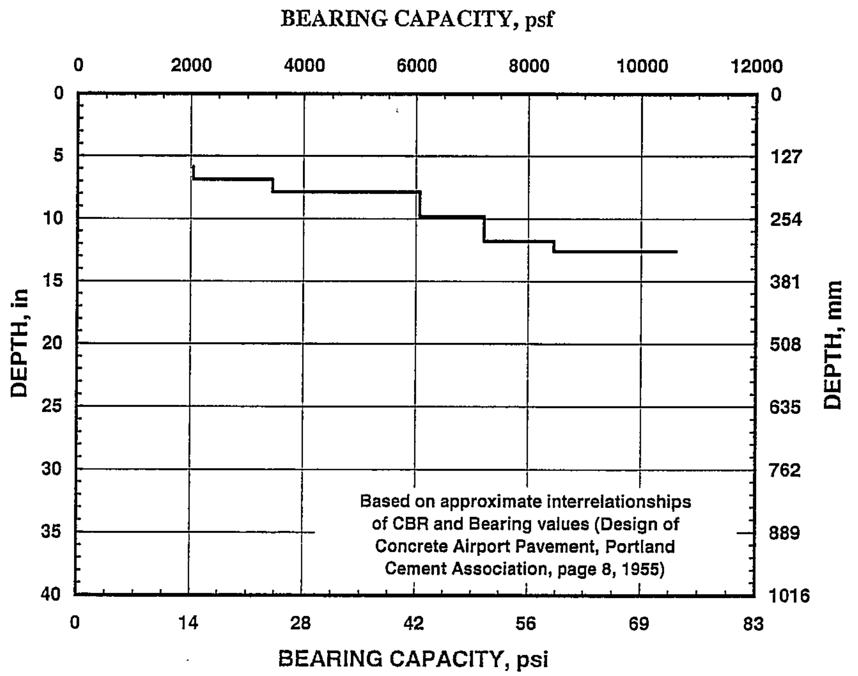
Date: 6-Aug-03
Soil Type(s): SM with rock fragments

Hammer
◉ 10.1 lbs.
○ 17.6 lbs.
○ Both hammers used

Soil Type
○ CH
○ CL
◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	150	2
2	175	2
4	200	2
8	225	2
8	250	2
10	275	2
10	300	2
10	320	2





DCP TEST DATA

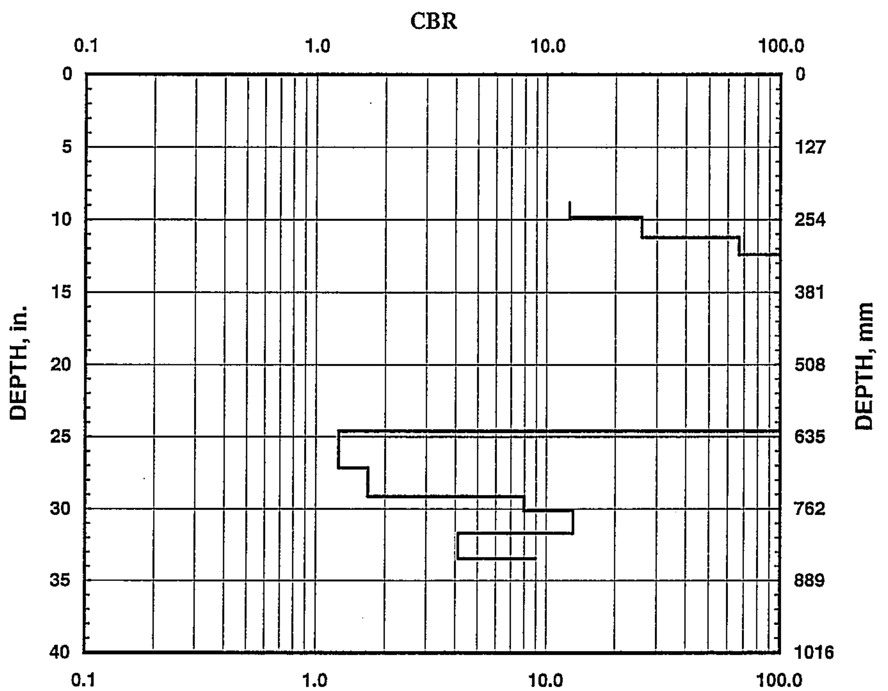
File Name: M362S10+50

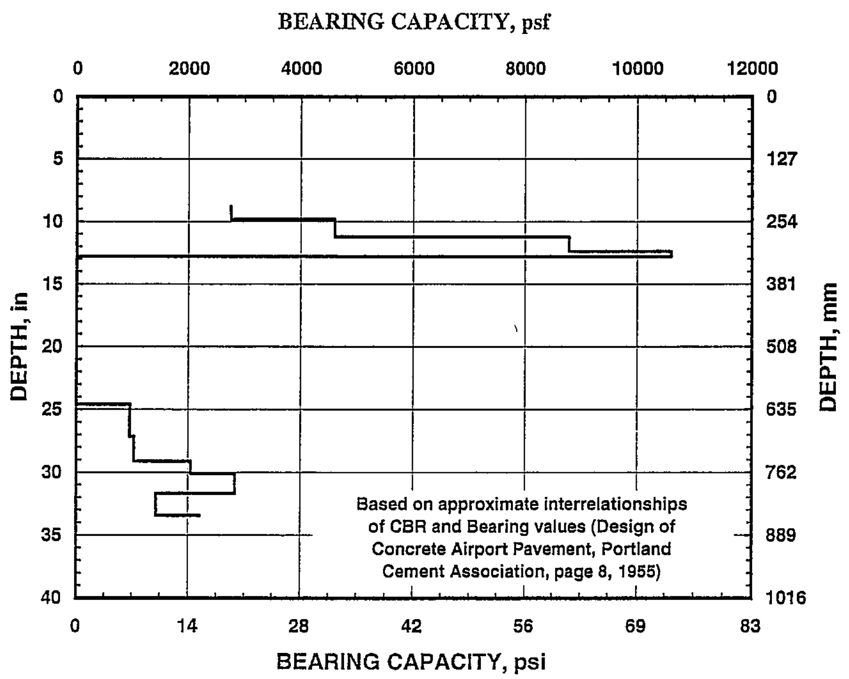
Project: *BLUE RIDGE PARKWAY*
Date: 6-Aug-03
Location: M362 STA 10+50
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	225	2
3	250	2
8	285	2
16	315	2
10	325	2
0	625	2
1	690	2
1	740	2
2	765	2
5	805	2
2	850	2





DCP TEST DATA

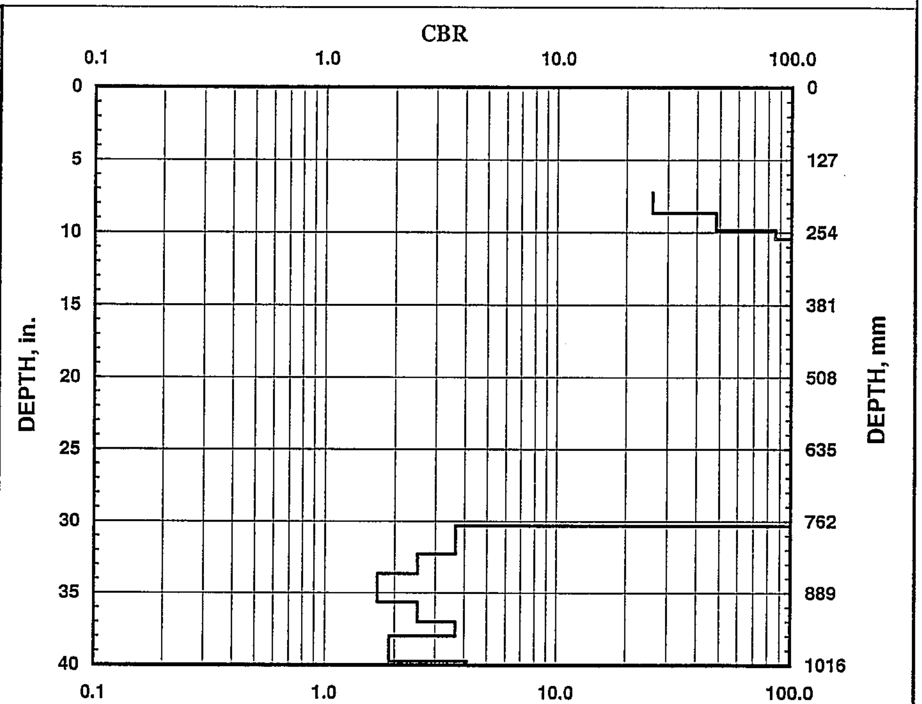
File Name: M362S23+00

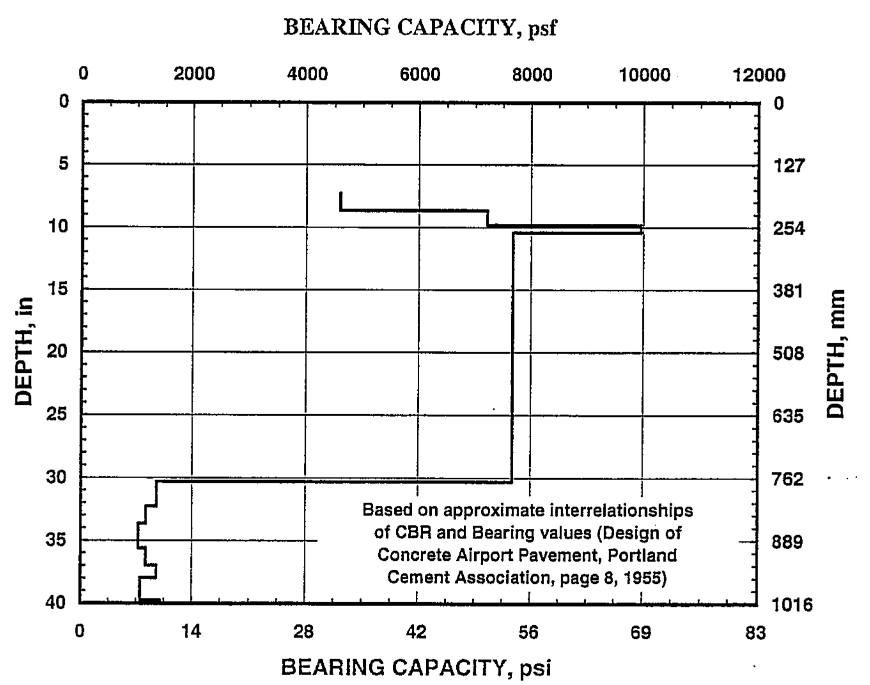
Project: *BLUE RIDGE PARKWAY*
Location: M362 STA 23+00
Date: 6-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	185	2
8	220	2
12	250	2
10	265	2
0	770	2
2	820	2
1	855	2
1	905	2
1	940	2
1	965	2
1	1010	2





DCP TEST DATA

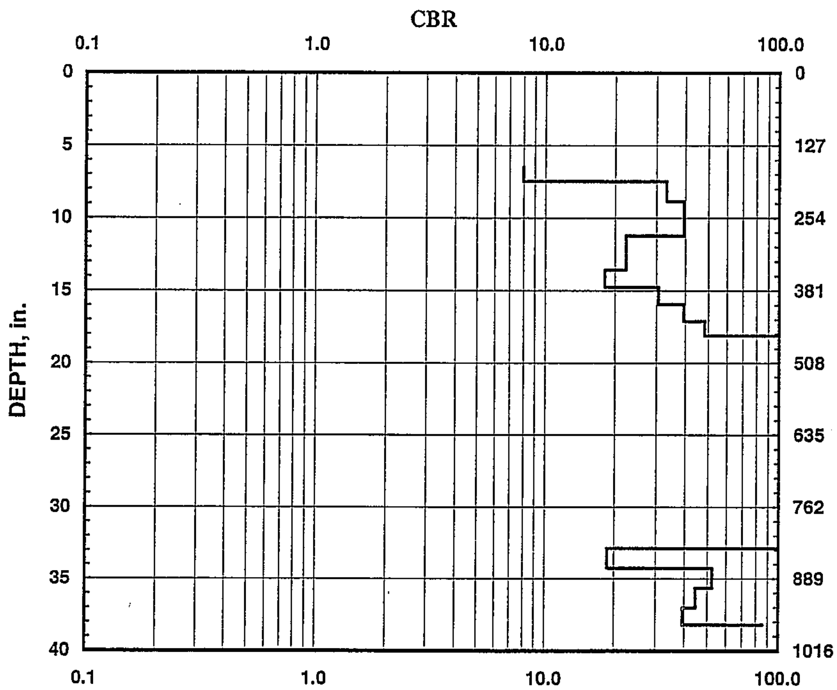
File Name: M362S51+00

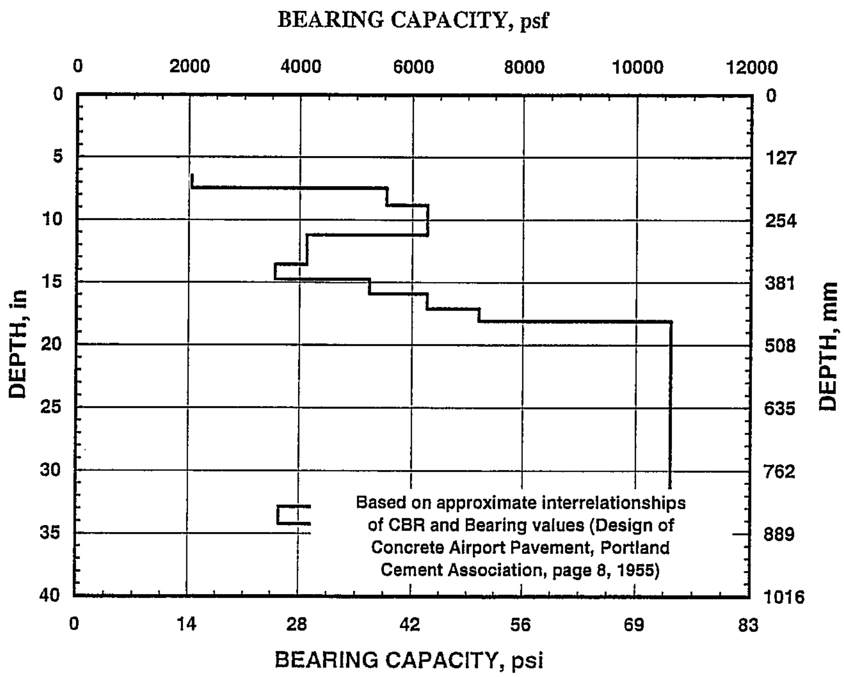
Project: *BLUE RIDGE PARKWAY*
Date: 6-Aug-03
Location: M362 STA 51+00
Soil Type(s): SM

Hammer
- ◉ 10.1 lbs.
- ○ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	165	2
2	190	2
10	225	2
10	255	2
10	285	2
4	305	2
8	345	2
5	375	2
8	405	2
10	435	2
10	460	2
0	835	2
6	870	2
15	905	2
13	940	2
10	970	2





Based on approximate interrelationships of CBR and Bearing values (Design of Concrete Airport Pavement, Portland Cement Association, page 8, 1955)

DCP TEST DATA

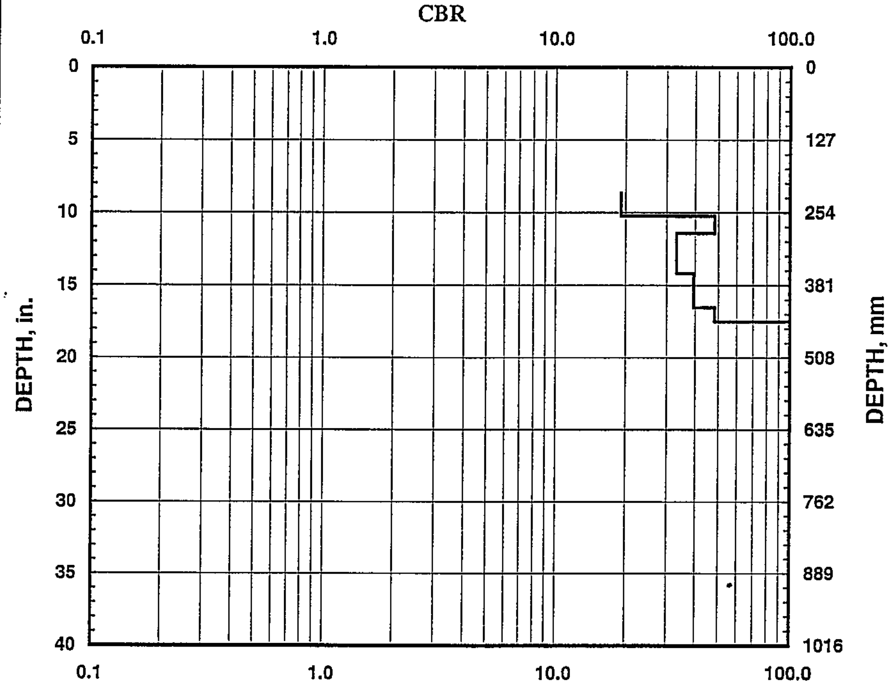
File Name: M363S10+50

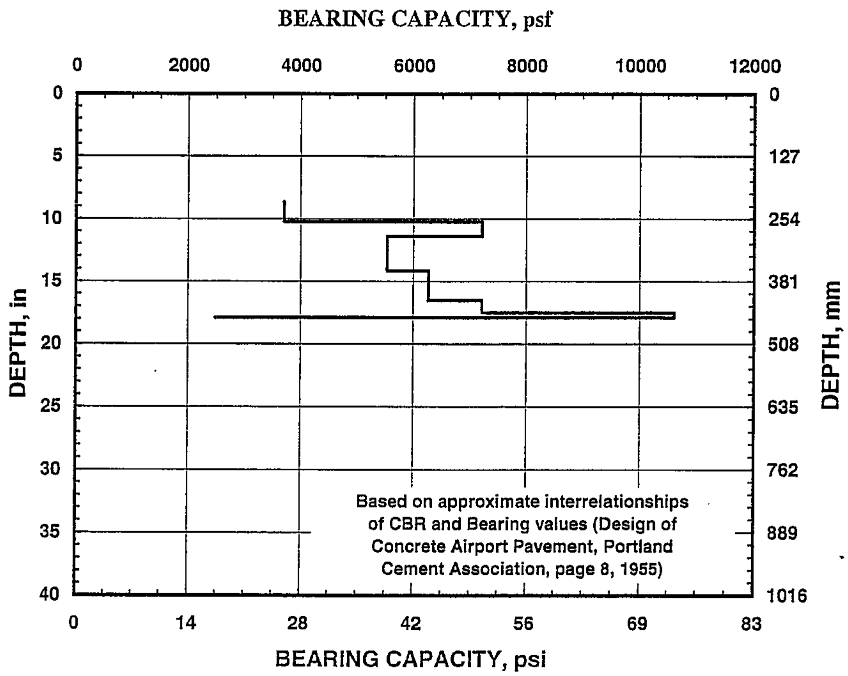
Project: *BLUE RIDGE PARKWAY*
Location: M363 STA 10+50
Date: 6-Aug-03
Soil Type(s): SM with Rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	220	2
7	260	2
12	290	2
10	325	2
10	360	2
10	390	2
10	420	2
10	445	2
8	455	2





Based on approximate interrelationships of CBR and Bearing values (Design of Concrete Airport Pavement, Portland Cement Association, page 8, 1955)

DCP TEST DATA

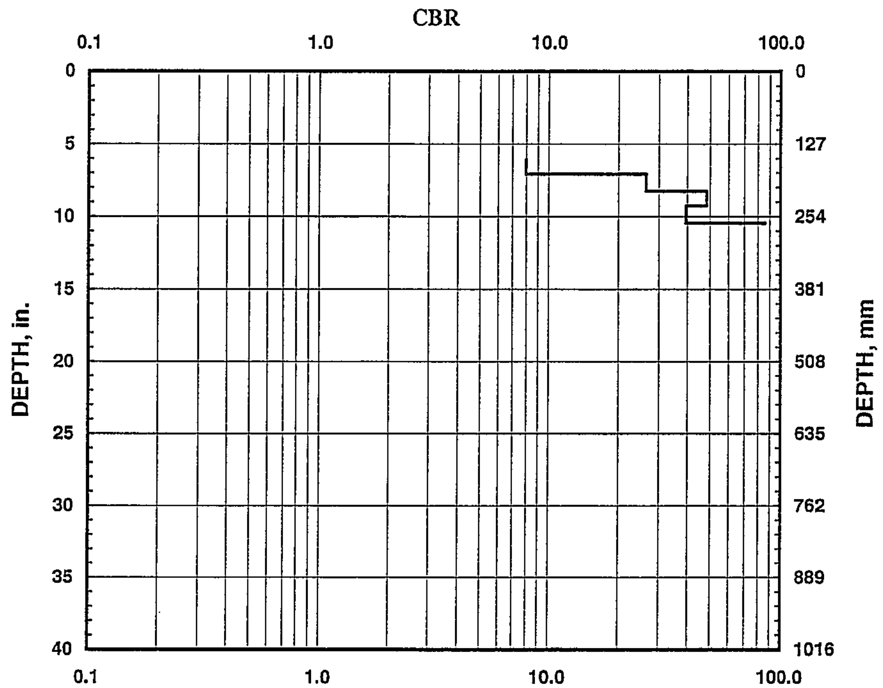
File Name: M363S34+00

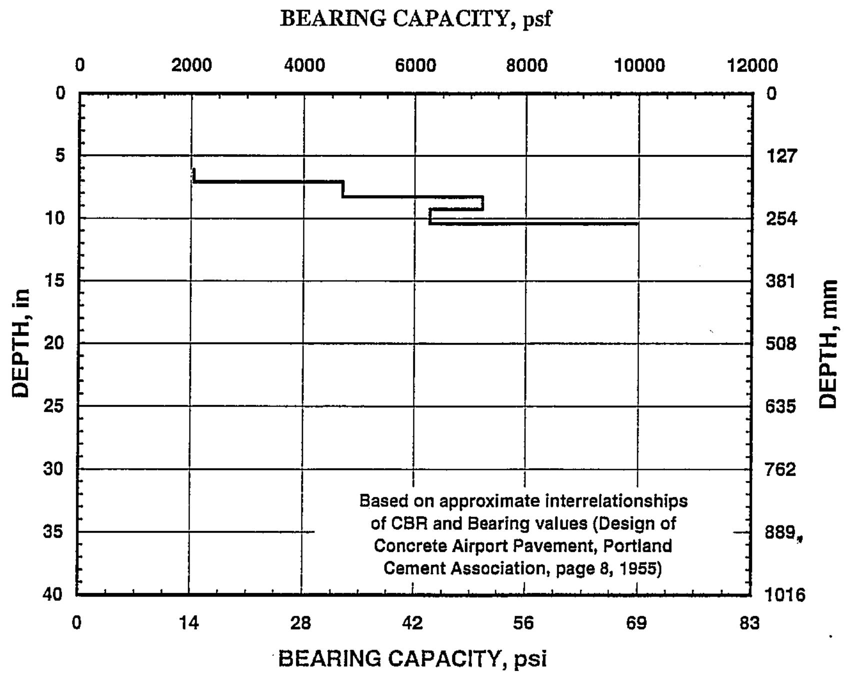
Project: *BLUE RIDGE PARKWAY* **Date:** 6-Aug-03
Location: M363 STA 34+00 **Soil Type(s):** SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	155	2
2	180	2
7	210	2
10	235	2
10	265	2





DCP TEST DATA

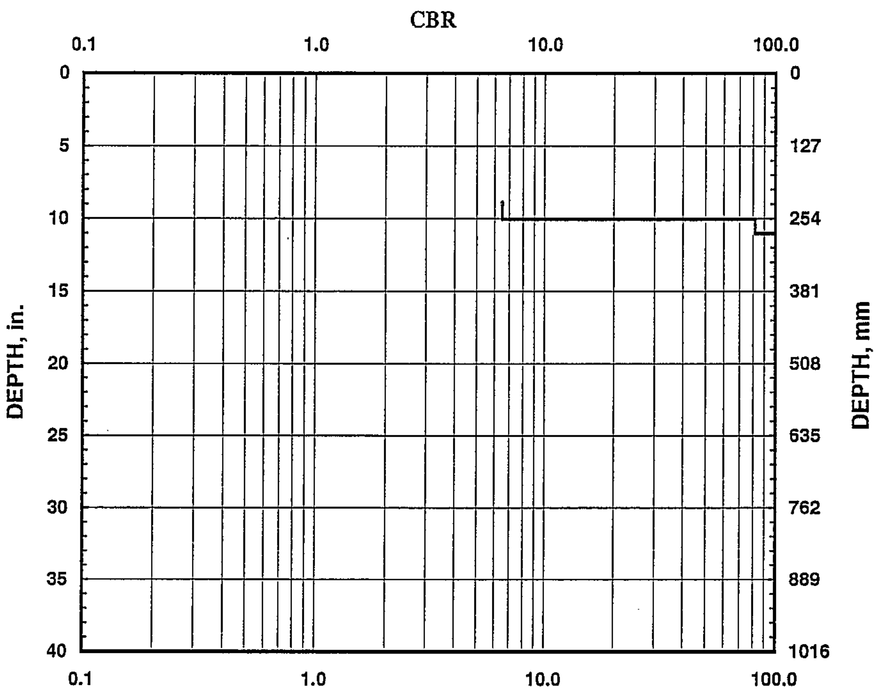
File Name: M367S21+50

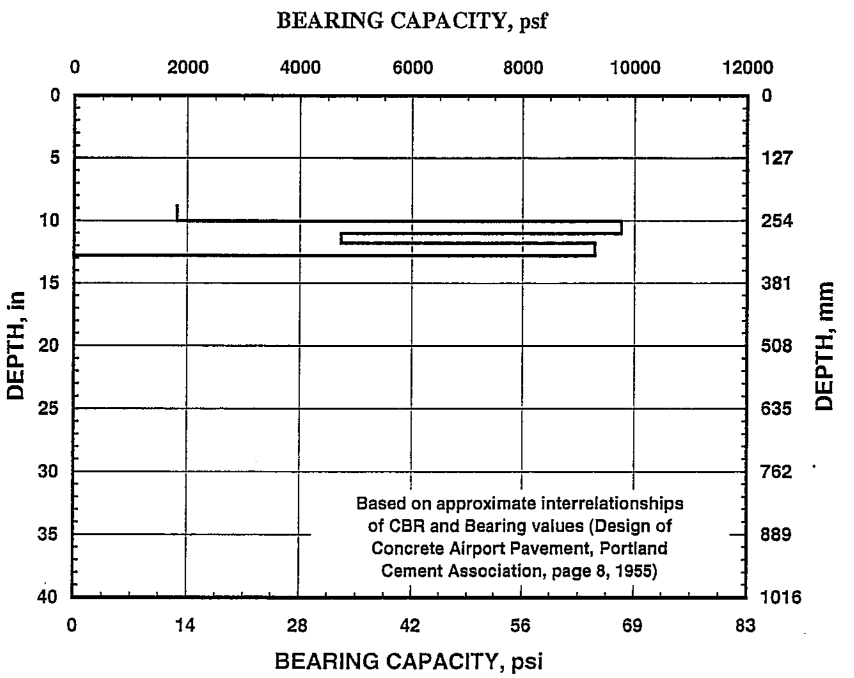
Project: *BLUE RIDGE PARKWAY*
Location: M367 STA 21+50
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	225	1
1	255	1
8	280	1
15	300	1
15	325	1
8	330	1





DCP TEST DATA

File Name: M367s39+00

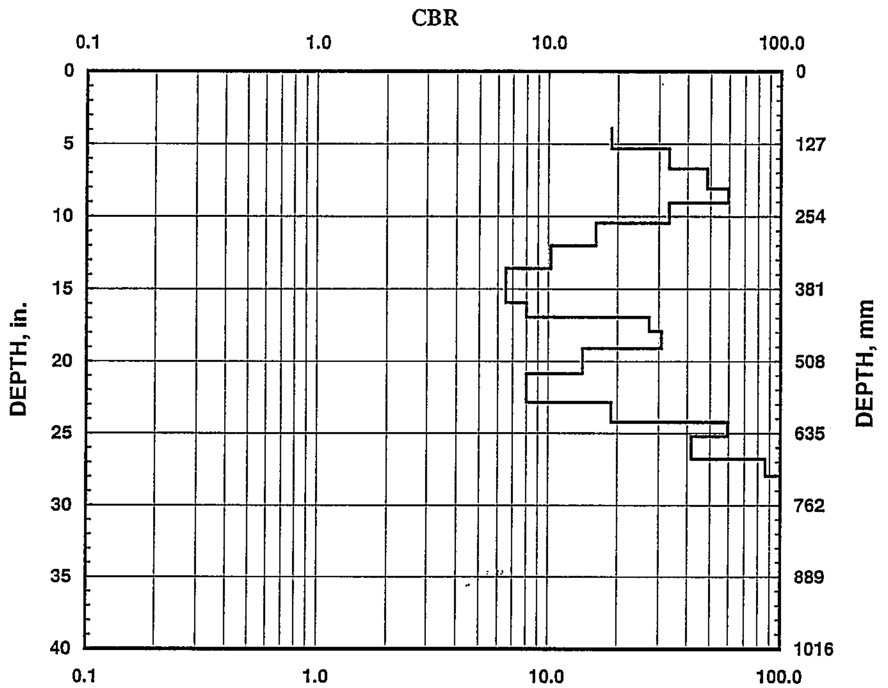
Project: *BLUE RIDGE PARKWAY*
Location: M367 STA 39+00

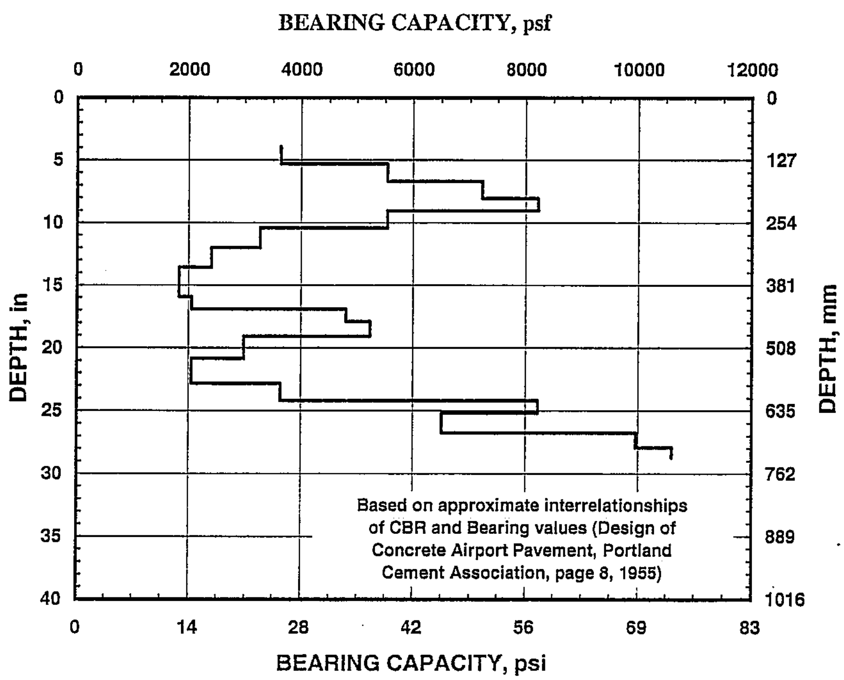
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	100	1
3	135	1
5	170	1
7	205	1
6	230	1
5	265	1
3	305	1
2	345	1
2	405	1
1	430	1
3	455	1
4	485	1
3	530	1
2	580	1
3	615	1
6	640	1
7	680	1
10	710	1
10	730	1





DCP TEST DATA

File Name: M368S12+50

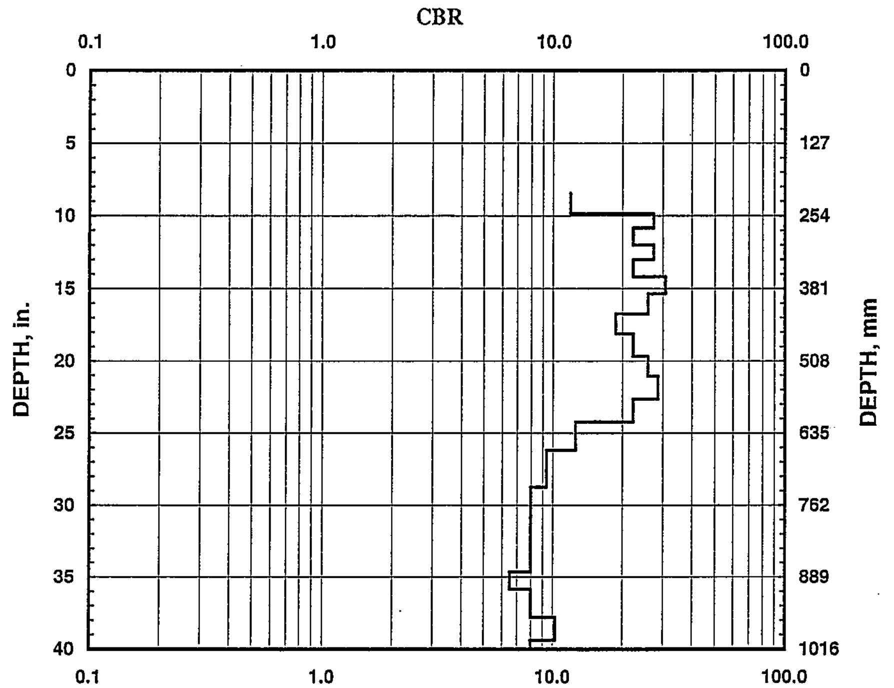
Project: *BLUE RIDGE PARKWAY*
Location: M368 STA 12+50

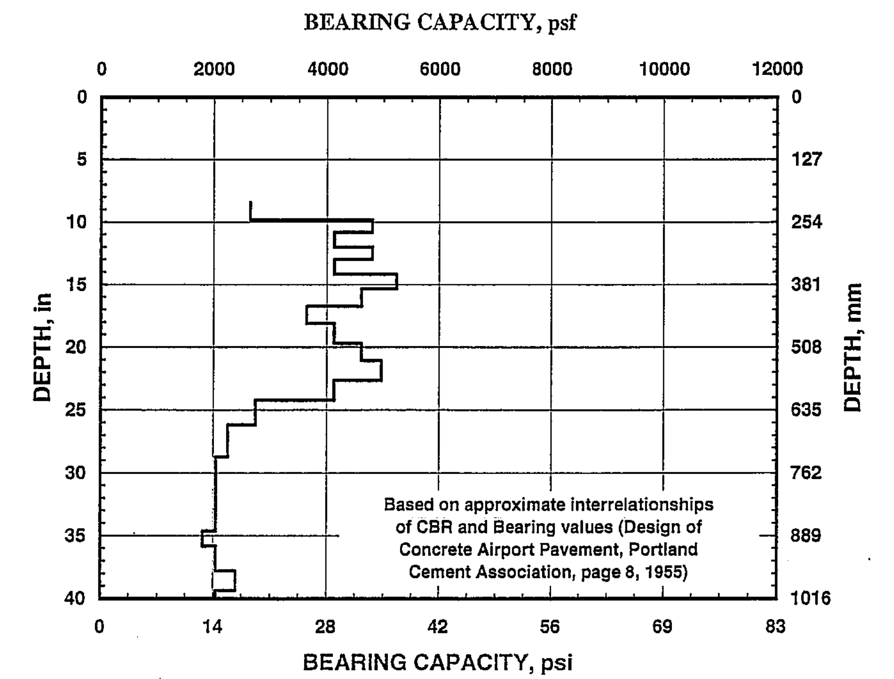
Date: 5-Aug-03
Soil Type(s): SM

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	215	1
2	250	1
3	275	1
3	305	1
3	330	1
3	360	1
4	390	1
4	425	1
3	460	1
4	500	1
4	535	1
5	575	1
4	615	1
3	665	1
3	730	1
2	780	1
2	830	1
2	880	1
1	910	1
2	960	1
2	1000	1
2	1050	1





DCP TEST DATA

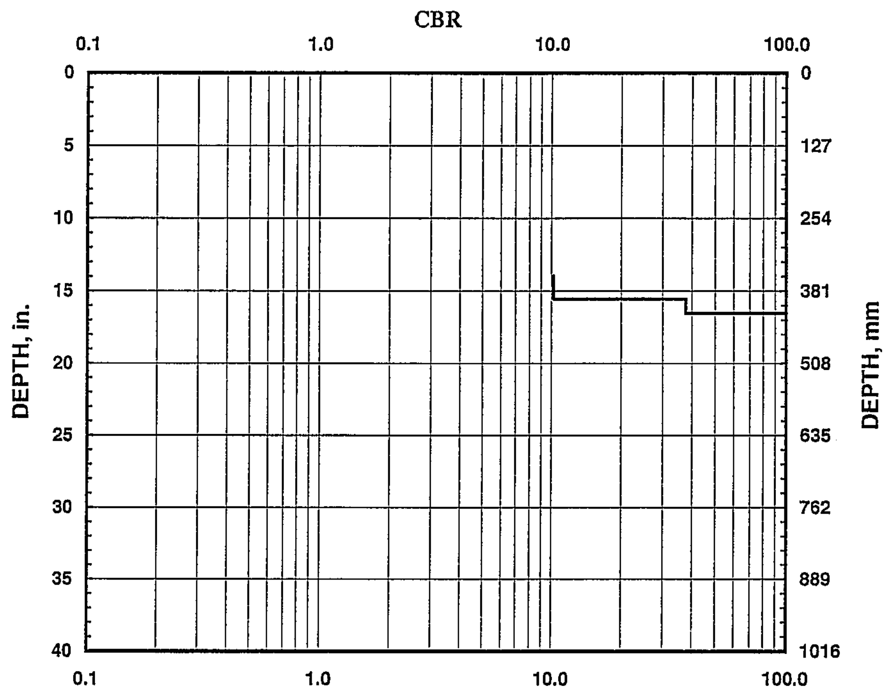
File Name: M368S38+00

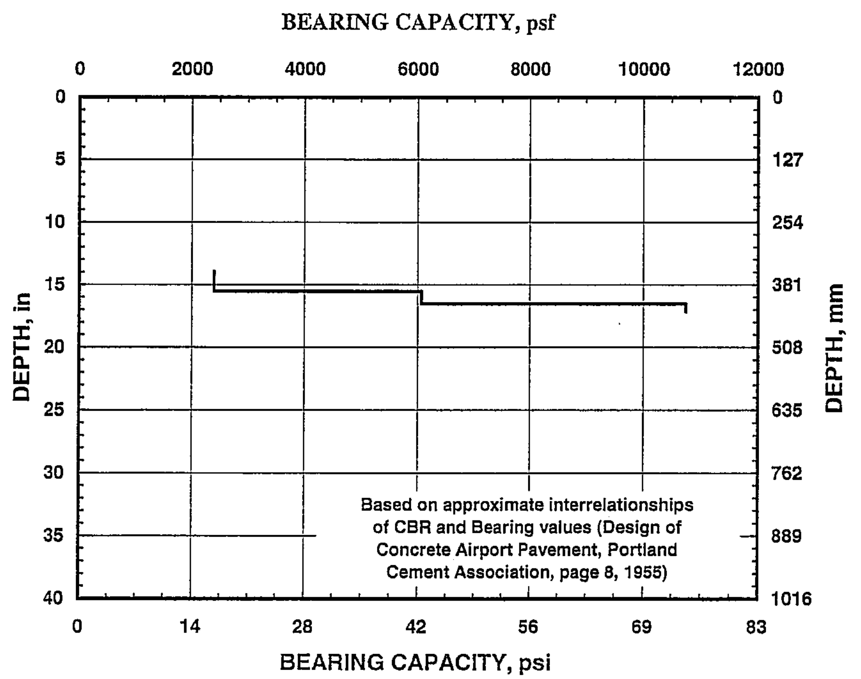
Project: *BLUE RIDGE PARKWAY*
Location: M368 STA 38+00
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	355	1
2	395	1
4	420	1
7	435	1





DCP TEST DATA

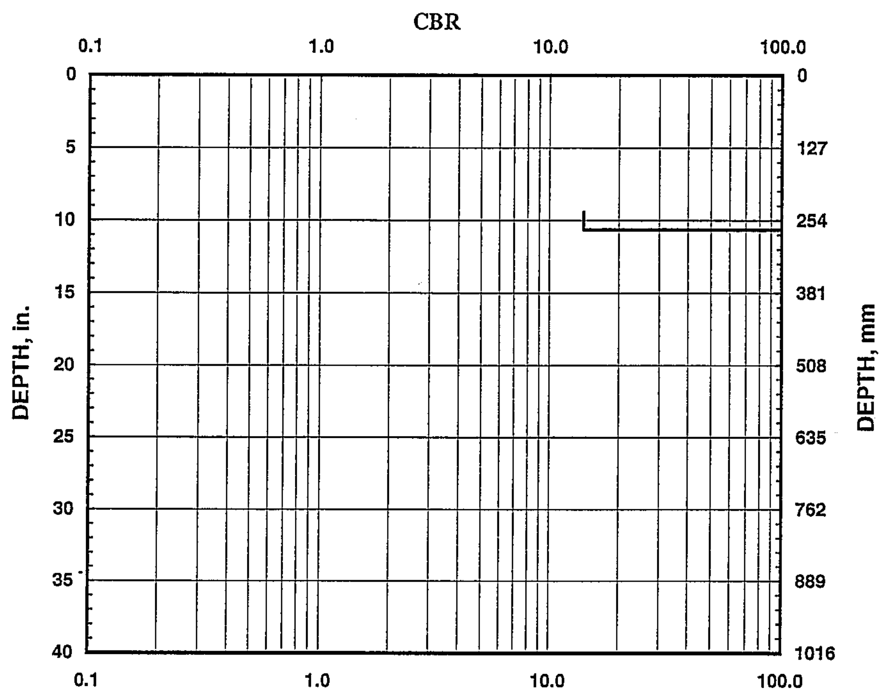
File Name: M369S4+50

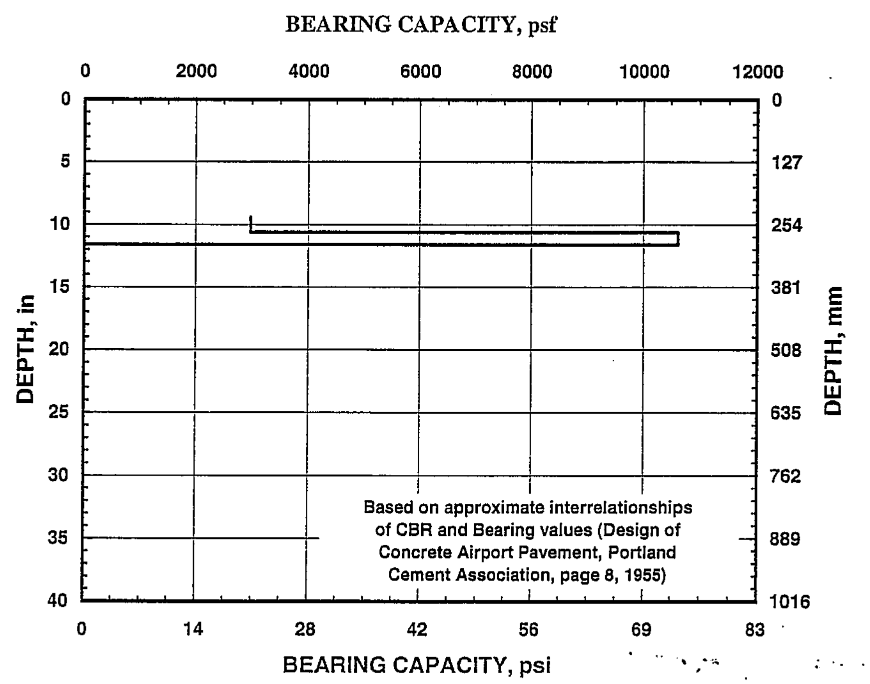
Project: *BLUE RIDGE PARKWAY*
Location: M369 STA 4+50
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ● 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ● All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	240	1
2	270	1
10	295	1
15	310	1





DCP TEST DATA

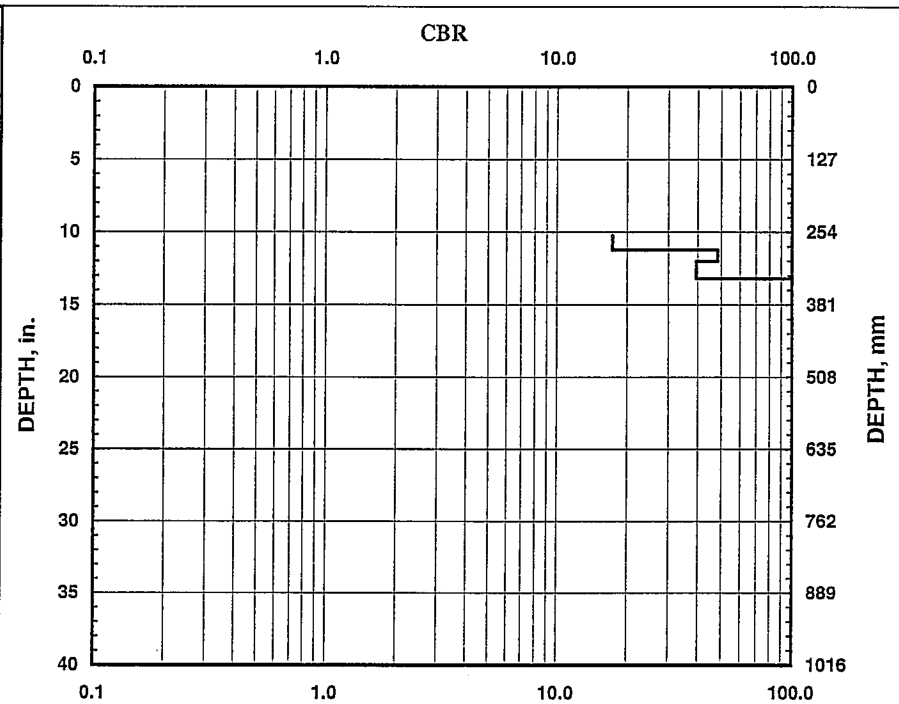
File Name: M369S14+00

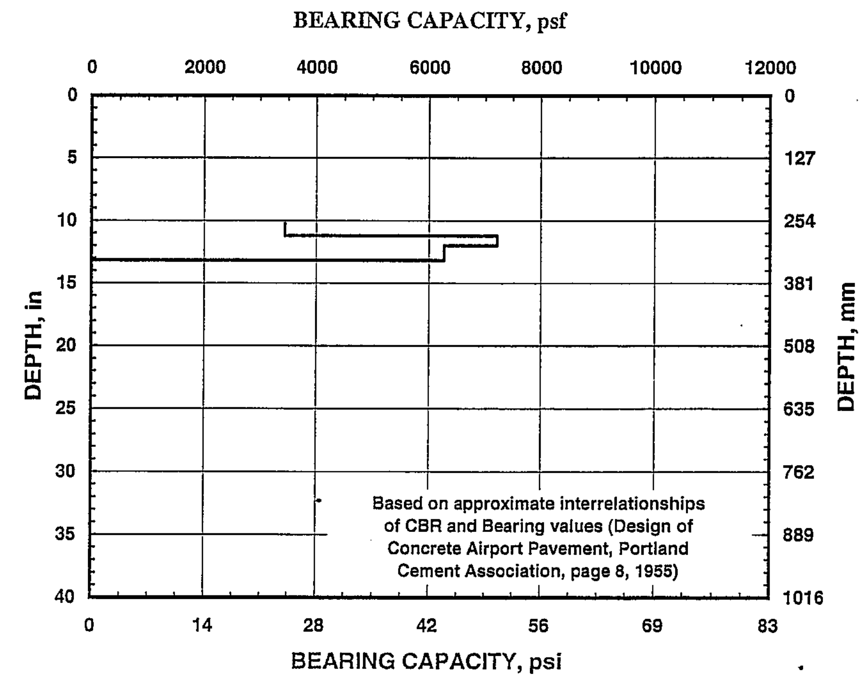
Project: *BLUE RIDGE PARKWAY*
Location: M369 STA 14+00
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	260	1
2	285	1
4	305	1
5	335	1
17	350	1





Based on approximate interrelationships of CBR and Bearing values (Design of Concrete Airport Pavement, Portland Cement Association, page 8, 1955)

DCP TEST DATA

File Name: M369S39+00

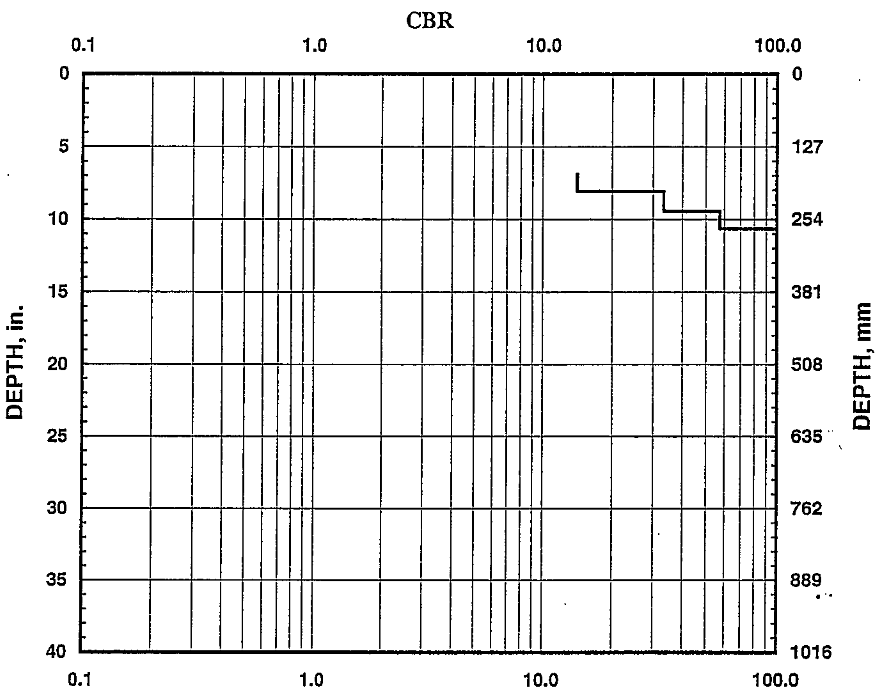
Project: *BLUE RIDGE PARKWAY*
Location: M369 STA 39+00

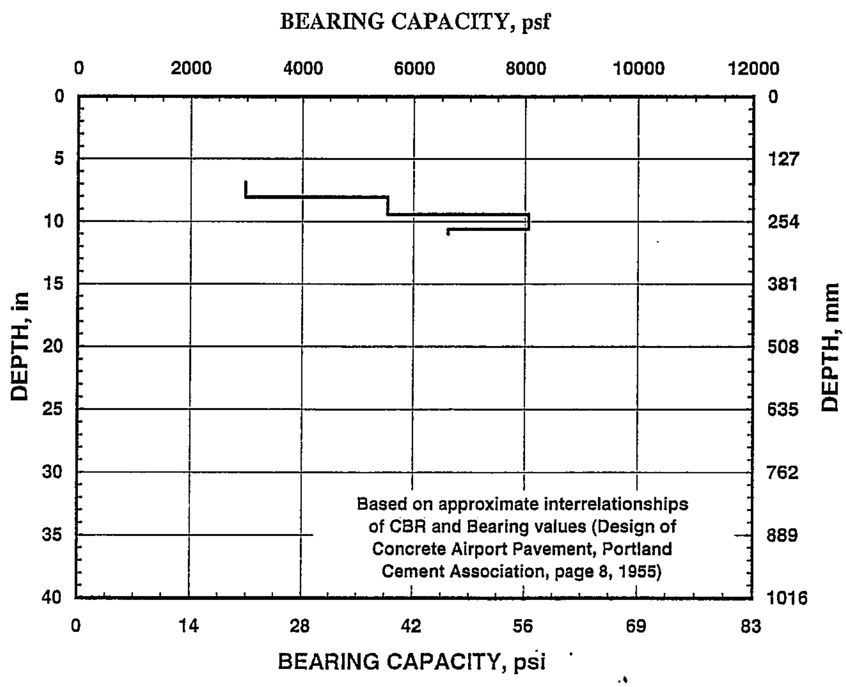
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	175	1
2	205	1
5	240	1
7	270	1
7	280	1





DCP TEST DATA

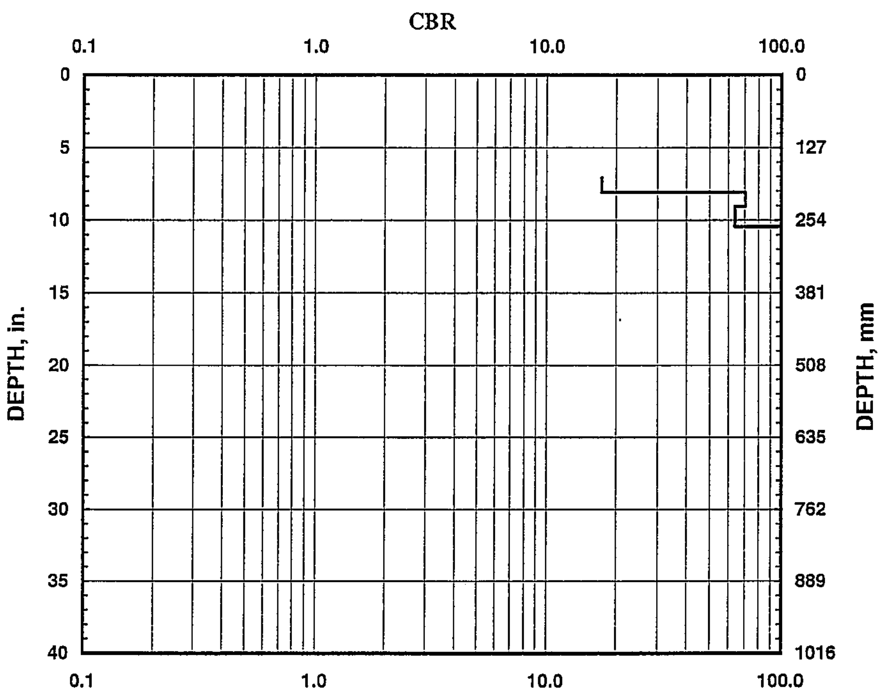
File Name: M370S13+00

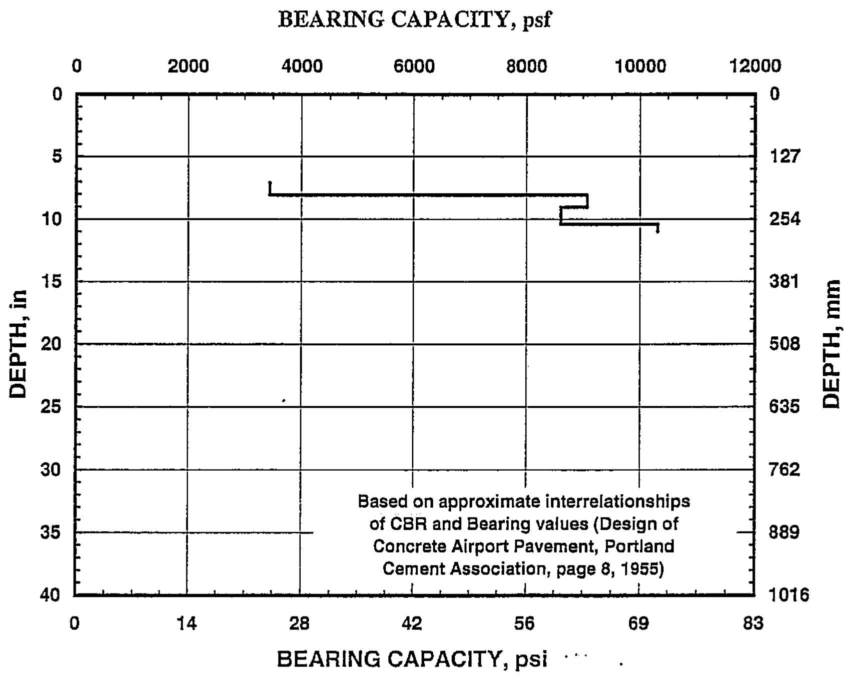
Project: *BLUE RIDGE PARKWAY* Date: 5-Aug-03
Location: M370 STA 13+00 Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	180	1
2	205	1
7	230	1
9	265	1
8	280	1





DCP TEST DATA

File Name: M370S38+00

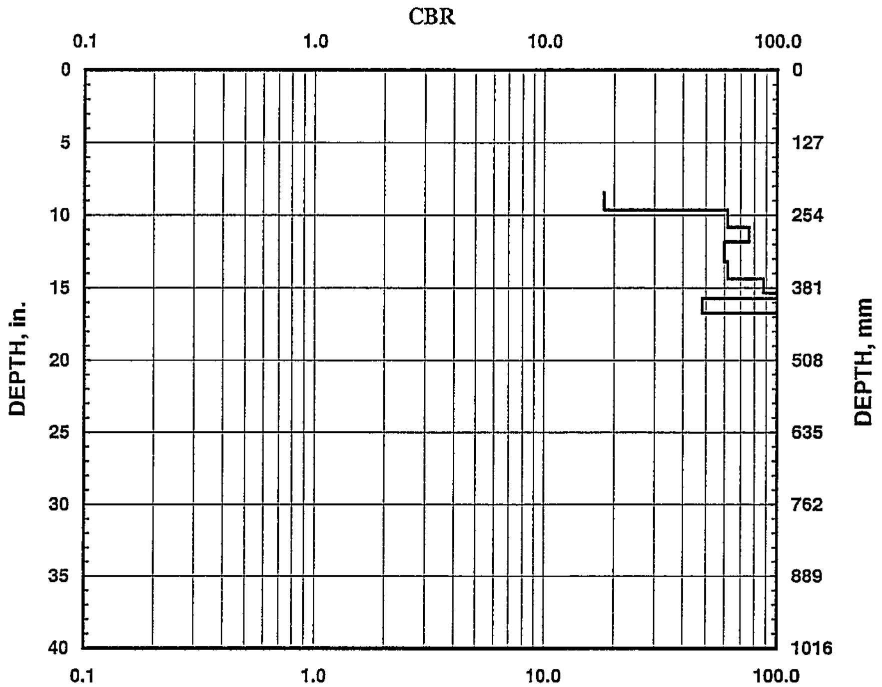
Project: *BLUE RIDGE PARKWAY* **Date:** 5-Aug-03

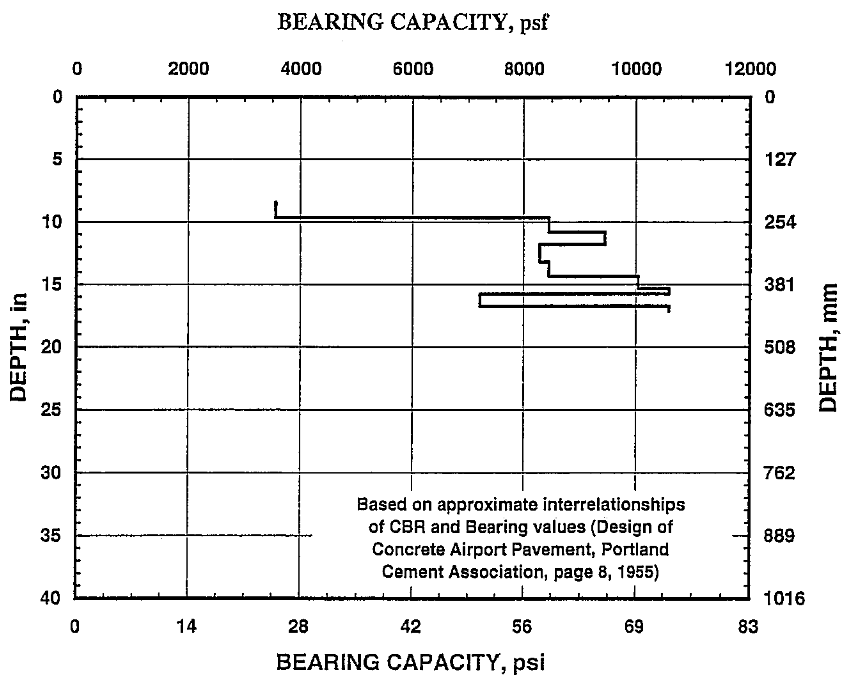
Location: M370 STA 38+00 **Soil Type(s):** SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ○ 17.6 lbs.
- ◉ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	215	2
5	245	2
15	275	2
15	300	2
17	335	2
15	365	2
17	390	2
10	400	2
10	425	1
5	435	1





DCP TEST DATA

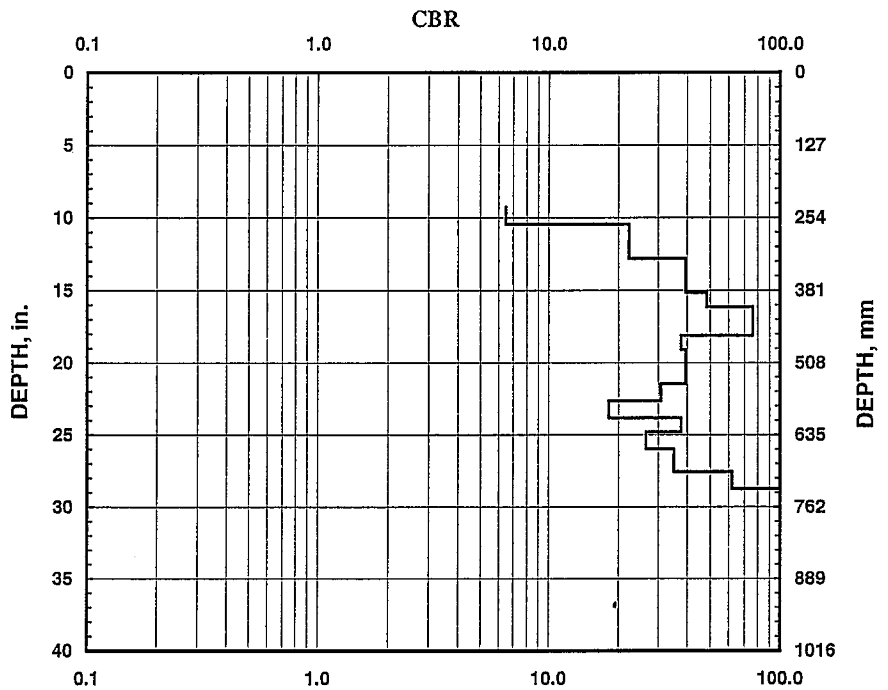
File Name: M371S15+00

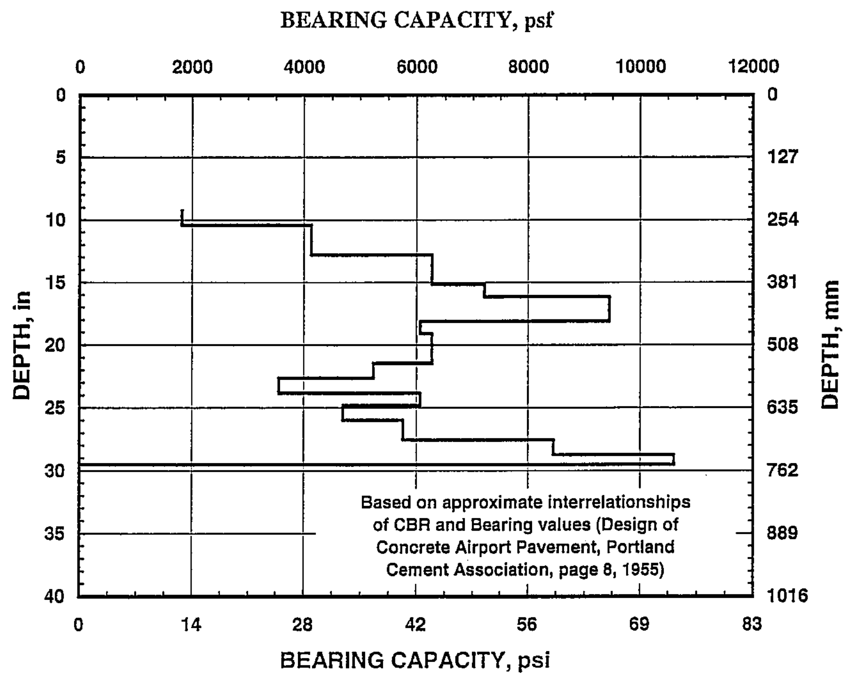
Project: *BLUE RIDGE PARKWAY* Date: 5-Aug-03
Location: M371 STA 15+00 Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	235	2
2	265	2
7	300	2
5	325	2
10	355	2
10	385	2
10	410	2
15	435	2
15	460	2
8	485	2
10	515	2
10	545	2
8	575	2
5	605	2
8	630	2
7	660	2
12	700	2
15	730	2
20	750	2





DCP TEST DATA

File Name: M371S30+00

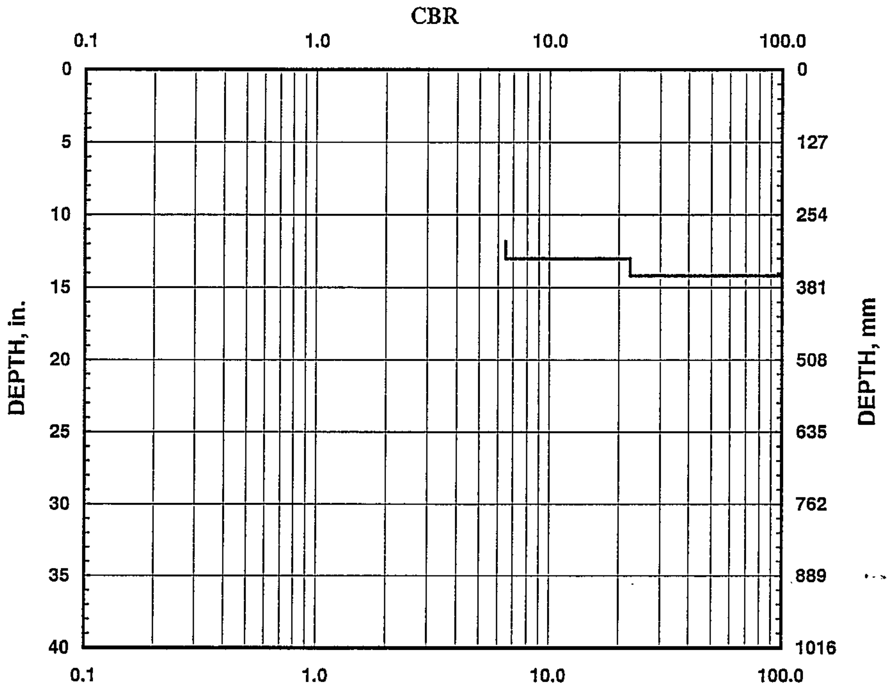
Project: *BLUE RIDGE PARKWAY*
Location: M371 STA 30+00

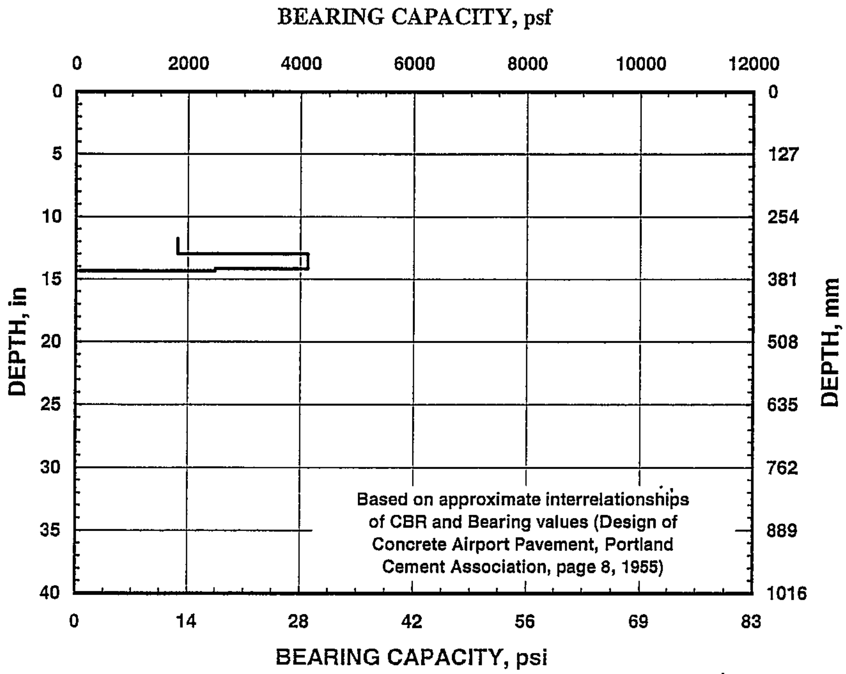
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ◉ 10.1 lbs.
- ○ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	300	2
2	330	2
6	360	2
8	365	2





DCP TEST DATA

File Name: M372S14+00

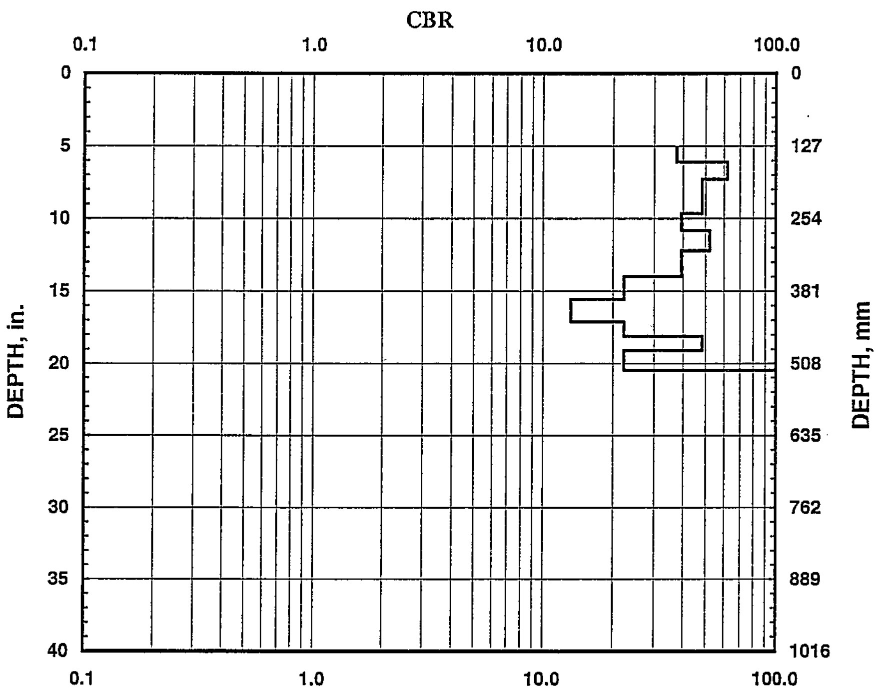
Project: *BLUE RIDGE PARKWAY*
Location: M372 STA 14+00

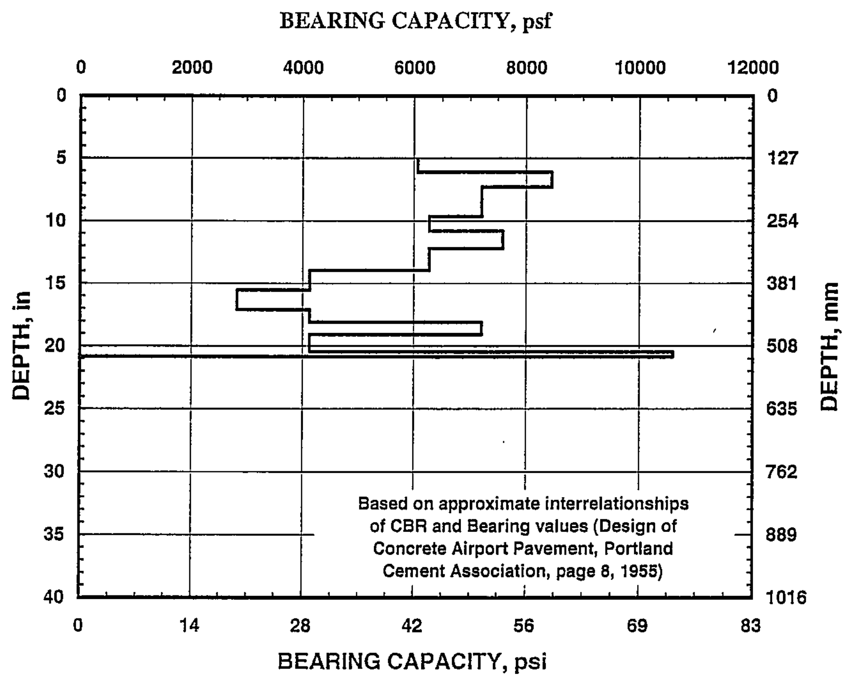
Date: 4-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ◉ 10.1 lbs.
- ○ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	130	2
8	155	2
15	185	2
12	215	2
12	245	2
10	275	2
15	310	2
15	355	2
8	395	2
5	435	2
5	460	2
10	485	2
7	520	2
10	530	2





DCP TEST DATA

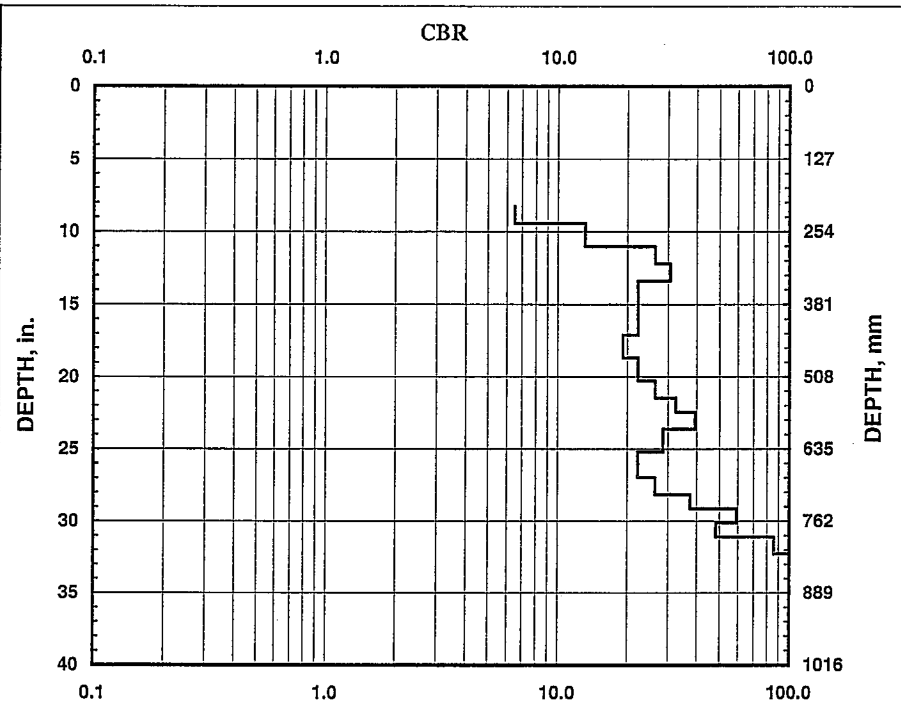
File Name: M373S17+00

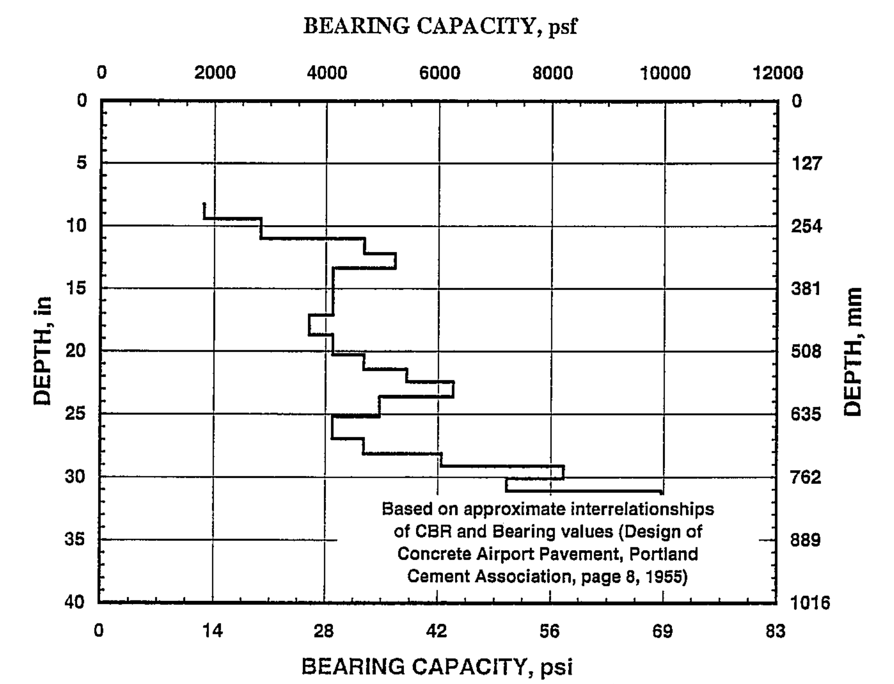
Project: *BLUE RIDGE PARKWAY*
Date: 4-Aug-03
Location: M373 STA 17+00
Soil Type(s): SM

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	210	2
2	240	2
5	280	2
7	310	2
8	340	2
8	380	2
6	410	2
5	435	2
7	475	2
8	515	2
7	545	2
7	570	2
10	600	2
10	640	2
9	685	2
7	715	2
8	740	2
12	765	2
10	790	2
20	820	2





DCP TEST DATA

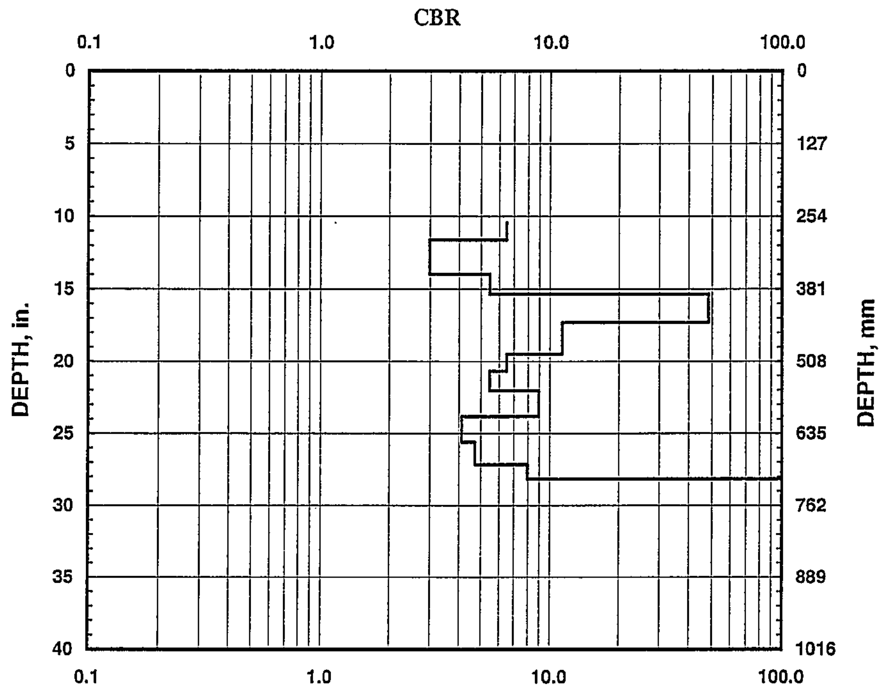
File Name: M373S37+00

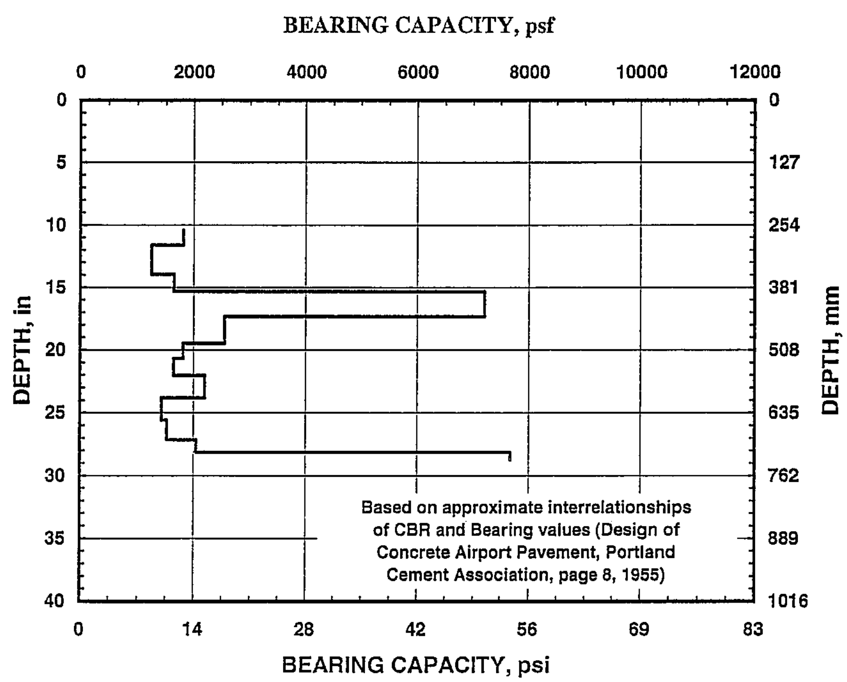
Project: *BLUE RIDGE PARKWAY* **Date:** 4-Aug-03
Location: M373 STA 37+00 **Soil Type(s):** ML/SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	265	1
1	295	1
1	355	1
1	390	1
10	440	1
3	495	1
1	525	1
1	560	1
2	605	1
1	650	1
1	690	1
1	715	1
10	730	1





DCP TEST DATA

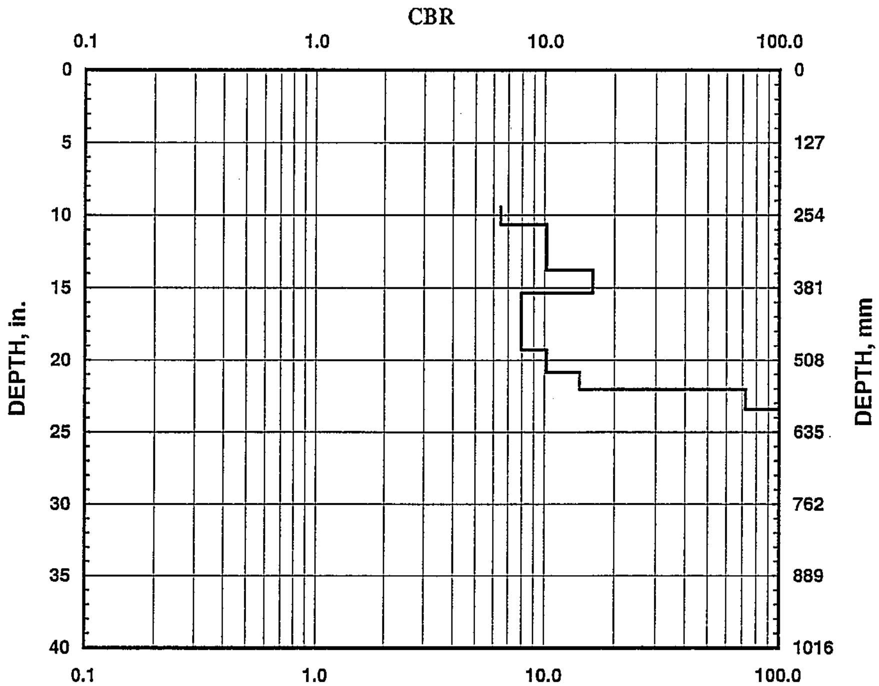
File Name: M374S36+00

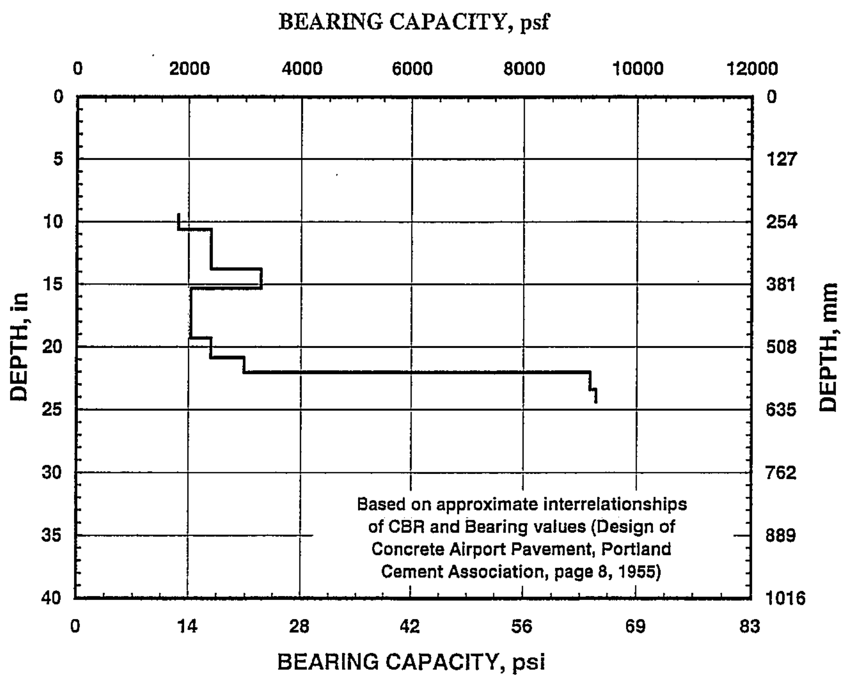
Project: *BLUE RIDGE PARKWAY*
Date: 4-Aug-03
Location: M374 STA 36+00
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	240	1
1	270	1
2	310	1
2	350	1
3	390	1
2	440	1
2	490	1
2	530	1
2	560	1
10	595	1
15	620	1





DCP TEST DATA

File Name: M375S0+00

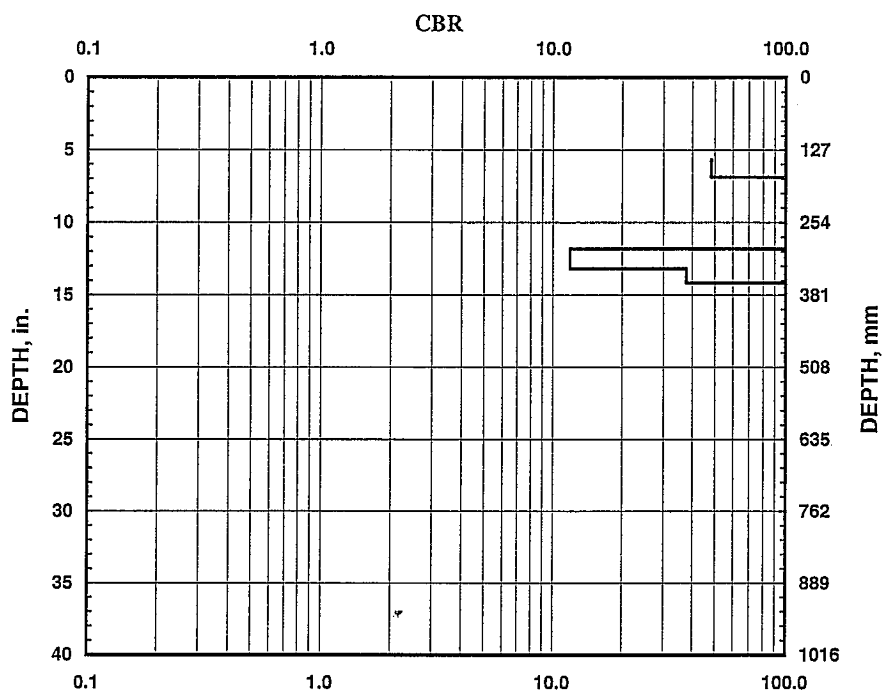
Project: *BLUE RIDGE PARKWAY*
Location: M375 STA 0+00

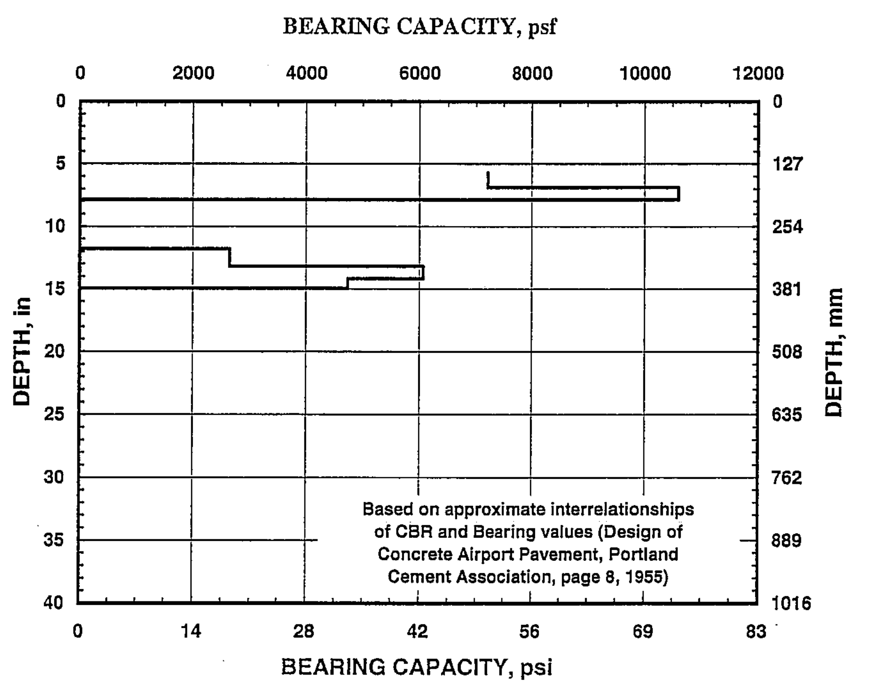
Date: 4-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ○ 17.6 lbs.
- ◉ Both hammers used

Soil Type
- ○ CH
- ◉ CL
- ○ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	145	2
12	175	2
25	200	2
45	220	2
0	300	1
2	335	1
4	360	1
15	380	1
20	400	1





DCP TEST DATA

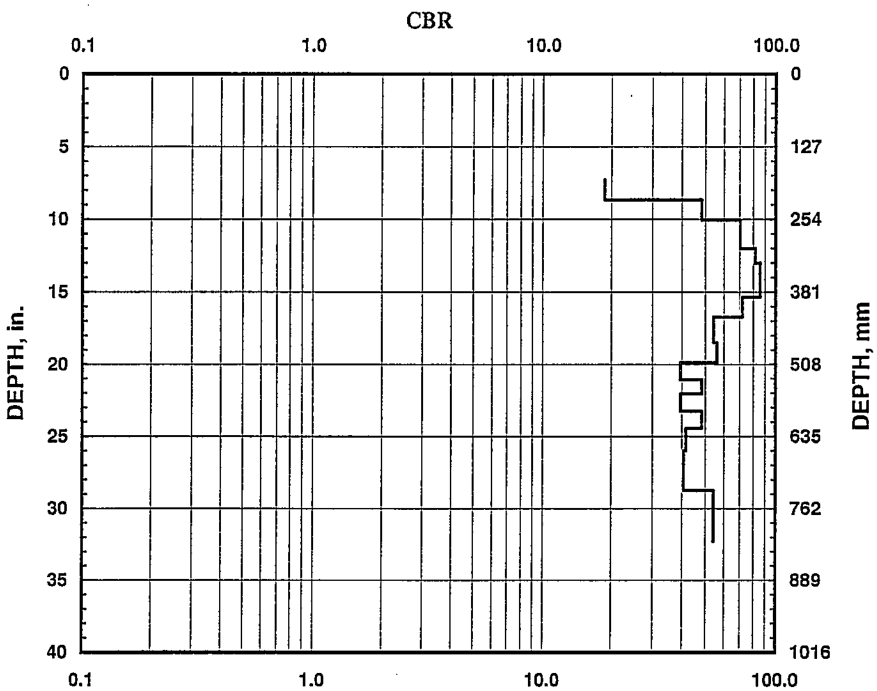
File Name: PA

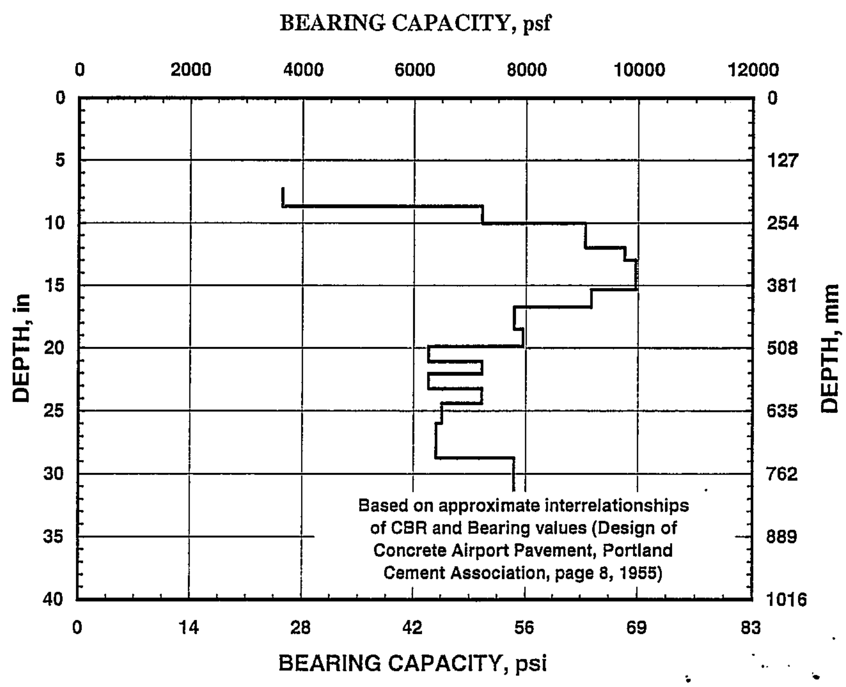
Project:	*BLUE RIDGE PARKWAY*	Date:	5-Aug-03
Location:	PICNIC AREA PARKING	Soil Type(s):	SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	185	1
3	220	1
7	255	1
7	280	1
7	305	1
8	330	1
10	360	1
10	390	1
10	425	1
10	470	1
8	505	1
5	535	1
5	560	1
5	590	1
6	620	1
7	660	1
6	695	1
6	730	1
10	775	1
10	820	1





DCP TEST DATA

File Name: PA20+50

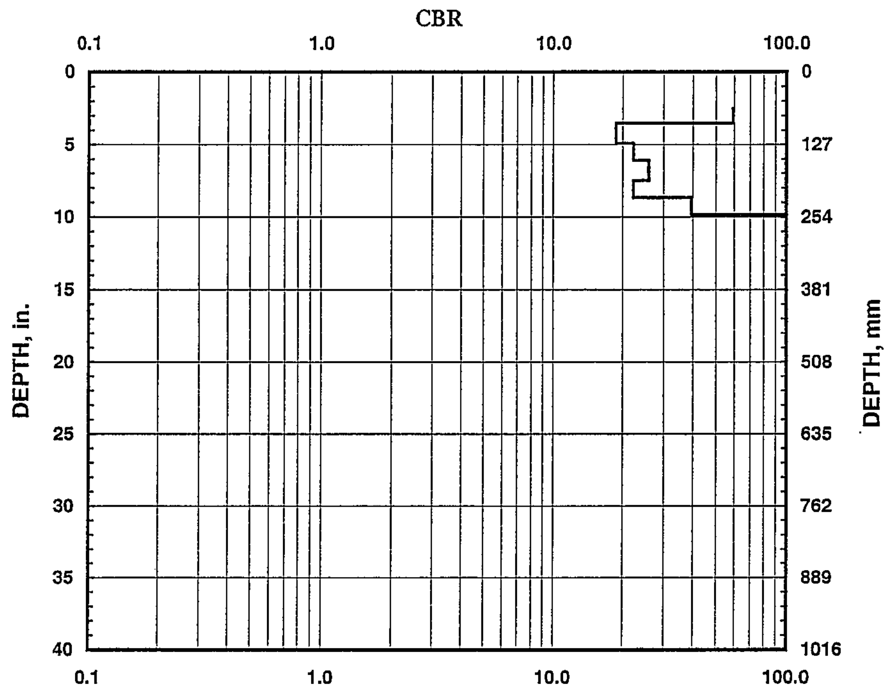
Project: *BLUE RIDGE PARKWAY*
Location: PICNIC ACCESS RD 20+50

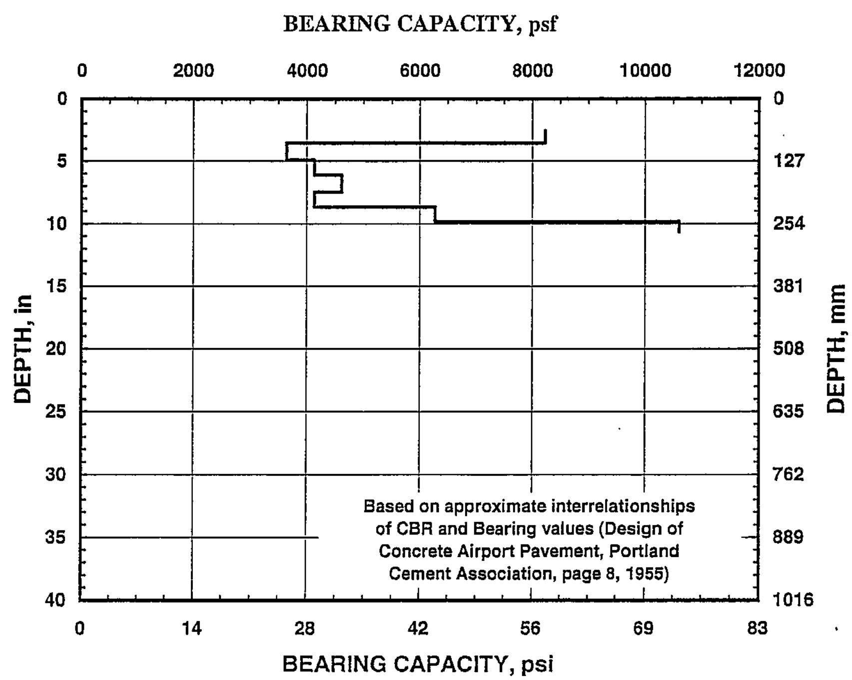
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	65	1
6	90	1
3	125	1
3	155	1
4	190	1
3	220	1
5	250	1
10	270	1





DCP TEST DATA

File Name: PA36+80

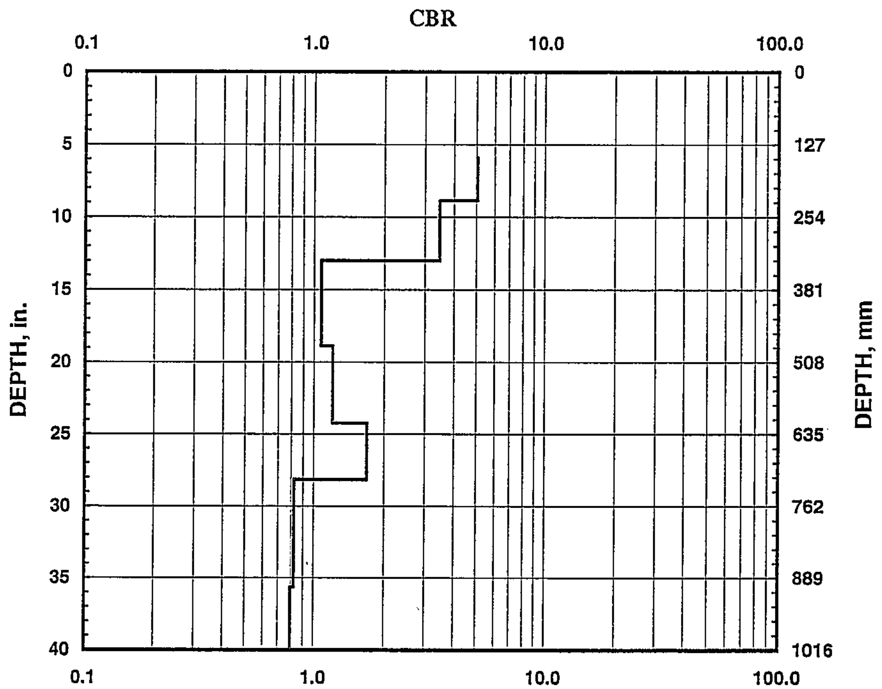
Project: *BLUE RIDGE PARKWAY*
Location: PICNIC ACCESS RD 36+80

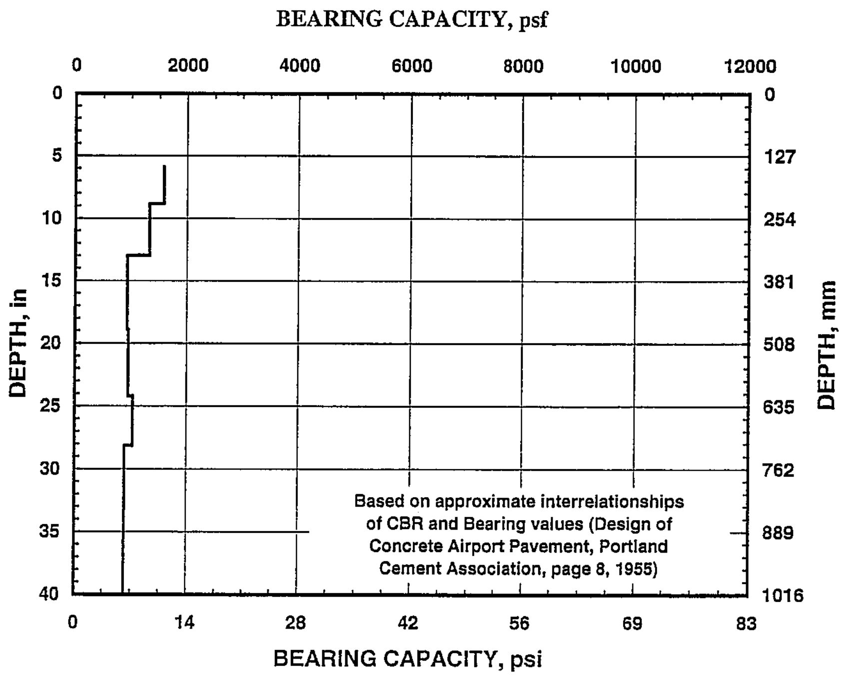
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	150	1
2	225	1
2	330	1
1	480	1
1	615	1
1	715	1
1	905	1
1	1100	1





DCP TEST DATA

File Name: CD-LOWER

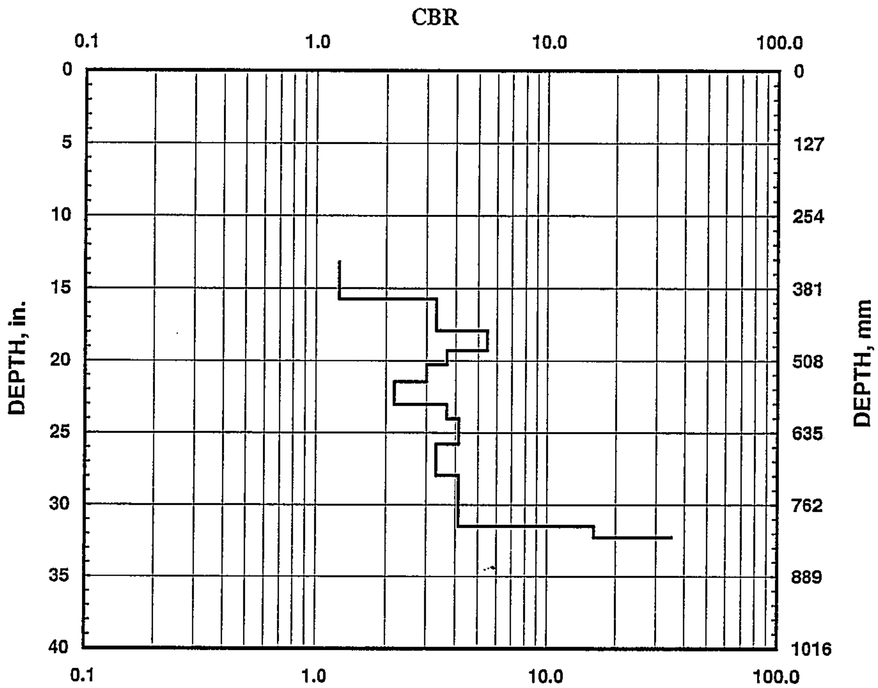
Project: *BLUE RIDGE PARKWAY*
Location: CRAGGY DOME - LOWER

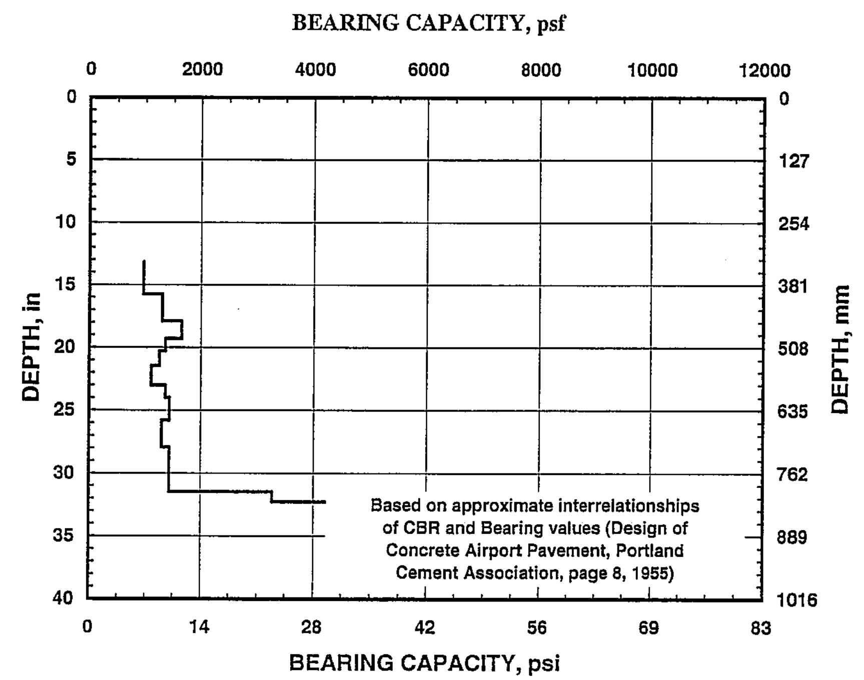
Date: 5-Aug-03
Soil Type(s): SM

Hammer
◉ 10.1 lbs.
○ 17.6 lbs.
○ Both hammers used

Soil Type
○ CH
○ CL
◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	335	2
1	400	2
2	455	2
2	490	2
1	515	2
1	545	2
1	585	2
1	610	2
2	655	2
2	710	2
2	755	2
2	800	2
3	820	2





DCP TEST DATA

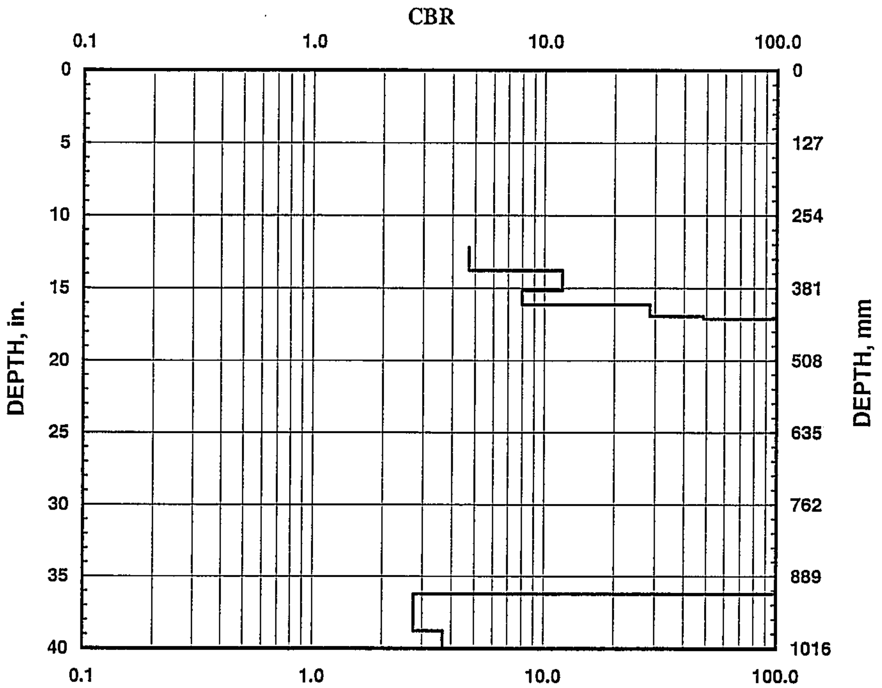
File Name: CD-UPPER

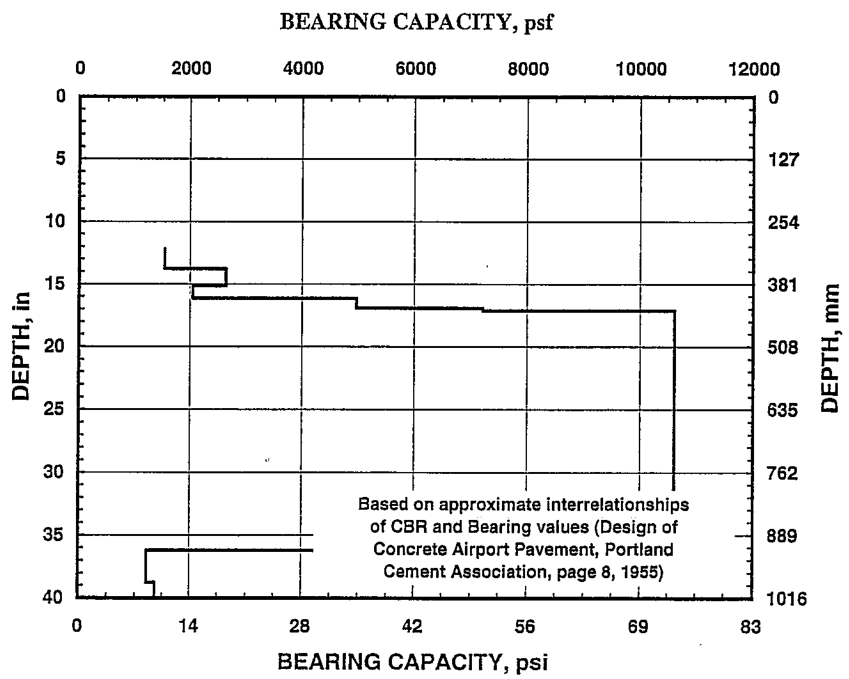
Project: *BLUE RIDGE PARKWAY*
Location: CRAGGY DOME - UPPER
Date: 5-Aug-03
Soil Type(s): SM with rock fragments

Hammer
- (●) 10.1 lbs.
- ( ) 17.6 lbs.
- ( ) Both hammers used

Soil Type
- ( ) CH
- ( ) CL
- (●) All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	310	2
2	350	2
4	385	2
2	410	2
5	430	2
2	435	2
0	920	2
2	985	2
3	1060	2
2	1155	2





SUBGRADE SOIL TEST RESULTS

TABLE 2
LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
359	52+00	Right	5	1	28.8	46	31	15	50.4	ML/A-7-6
				2	21.6	33	27	6	34.9	SM/A-2-4
360	24+00	Right	4.25	Asphalt Core Only						
360	50+00	Left	5.5	1 (3)	67.9	65	NP	NP	61.5	ML/A-7-6
				2	15.8	32	NP	NP	29.3	SM/A-2-4
361	51+00	Right	7	1	10.7	------	------	------	26.7	SM/A-2-4
362	10+50	Right	4.25	1	4.5	------	------	------	------	SM/A-2-4
				2	No Sample					
362	23+00	Right	5	1	26.0	------	------	------	37.7	SM/A-4
				2	32.9	------	------	------	------	SM/A-4
362	51+00	Left	4	1	7.3	------	------	------	------	SM/A-2-4
				2	9.7	------	------	------	------	SM/A-2-4
363	10+50	Right	4	1	11.1	33	NP	NP	28.1	SM/A-2-4
				2	11.8	------	------	------	------	SM/A-2-4

Note: (1) Measurements determined in field by Arcadis.
(2) Most soil samples contained significant amount of rock fragments.
(3) Material contains significant amount of mica.

TABLE 2 - (continued)
LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
363	34+00	Left	4.5	1	17.8	------	------	------	24.4	SM/A-2-4
				2	10.4	------	------	------	------	SM/A-2-4
364	3+50	Left	4.5	1	2.8	------	------	------	------	SM/A-2-4
364	36+00	Left	4	1	11.1	------	------	------	------	SM/A-2-4
				2	5.0	------	------	------	------	SM/A-2-4
365	11+00	Right	4.5	1	22.2	------	------	------	32.3	SM/A-2-4
				2	10.3	------	------	------	------	SM/A-2-4
366	11+00	Right	5	1	14.6	------	------	------	------	SM/A-2-4
				2	12.8	34	NP	NP	24.1	SM/A-2-4
366	15+00	Left	4.5	1	9.1	------	------	------	------	SM/A-2-4
366	43+00	Right	3.5	1	5.5	------	------	------	------	SM/A-2-4
				2	4.2	------	------	------	------	SM/A-2-4
367	21+50	Right	3	No Samples						
367	39+00	Left	3.25	1	11.1	------	------	------	28.0	SM/A-2-4
				2	9.9	------	------	------	22.4	SM/A-2-4

TABLE 2 - (continued)
LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
368	12+50	Right	4	1	19.9	------	------	------	34.9	SM/A-2-4
				2	20.6	------	------	------	------	SM/A-2-4
368	38+00	Right	4	1	15.2	41	NP	NP	31.3	SM/A-2-4
369	4+50	Left	3.5	1	12.2	------	------	------	------	SM/A-2-4
				2	4.7	------	------	------	------	SM/A-2-4
369	14+00	Left	4	1	9.9	------	------	------	27.1	SM/A-2-4
				2	9.6	------	------	------	------	SM/A-2-4
369	39+00	Right	4	1	5.5	------	------	------	21.0	SM/A-2-4
370	13+00	Left	3.5	1	10.3	------	------	------	------	SM/A-2-4
				2	8.0	32	NP	NP	21.7	SM/A-2-4
370	38+00	Right	4.5	1	9.7	------	------	------	31.2	SM/A-2-4
				2	7.2	------	------	------	------	SM/A-2-4

TABLE 2 - (continued)
LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
371	15+00	Right	3	1	11.3	------	------	------	23.1	SM/A-2-4
				2	14.9	------	------	------	------	SM/A-2-4
371	25+00	Left	3	1	10.9	------	------	------	27.2	SM/A-2-4
				2	28.3	------	------	------	46.3	SM/A-4
371	30+00	Right	3.5	1	11.3	------	------	------	22.7	SM/A-2-4
				2	6.7	------	------	------	------	SM/A-2-4
372	14+00	Left	3	1	17.9	25	24	1	37.8	SM/A-4
372	39+50	Right	3.5	1	12.6	------	------	------	17.7	SM/A-2-4
				2	18.0	------	------	------	32.6	SM/A-2-4
373	17+00	- - -	3.25	1	13.4	------	------	------	32.1	SM/A-2-4
373	37+00	Right	3.5	1	19.3	------	------	------	50.4	ML/A-4
				2	21.2	------	------	------	40.6	SM/A-4

TABLE 2 - (continued)
LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
373	49+50	Left	3	1	16.6	33	31	2	39.6	SM/A-4
				2	7.0	------	------	------	------	SM/A-2-4
374	36+00	Left	3	1	19.7	34	NP	NP	40.3	SM/A-4
				2	3.1	------	------	------	------	SM/A-2-4
375	0+00	Left	2.5	1	14.2	29	24	5	48.2	SM/A-4
				2	0.9	------	------	------	------	SM/A-2-4
PA	20+50	Left	3.5	1	7.9	------	------	------	------	SM/A-2-4
				2	20.0	------	------	------	------	SM/A-2-4
PA	36+80	Left	4.5	1	27.4	------	------	------	33.2	SM/A-2-4
				2	27.8	------	------	------	------	SM/A-2-4
Picnic Area			2	1	8.7	------	------	------	23.2	SM/A-2-4
				2	4.9	------	------	------	------	SM/A-2-4

TABLE 2 - (continued)
LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			%Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
Visitor Center			3	1	20.5	------	------	------	28.2	SM/A-2-4
				2	29.4	------	------	------	------	SM/A-2-4
Craggy Dome- Upper Tier			2.5	1	10.0	------	------	------	------	SM/A-2-4
				2	0.8	------	------	------	------	SM/A-2-4
Craggy Dome - Lower Tier			2.5	1	33.1	------	------	------	36.8	SM/A-2-4

HOT MIX ASPHALT (HMA)
TEST RESULTS

Table 3
Asphalt Pavement Cores
Blue Ridge Parkway - Section 2P
Asheville, North Carolina

Core No.	Core Location	Layer	Thickness (in.)	Bulk Specific Gravity	Absorption (%)
1	MM 360 Station 24+00	Surface Binder Base	1.0 1.5 2.0	Damaged 2.304 2.397	Damaged 0.98 0.36
2	MM 361 Station 51+00	Surface Binder Base	1.2 3.0 2.7	2.299 2.313 2.407	0.36 2.58 0.91
3	MM 365 Station 11+00	Surface Base	1.5 2.3	2.253 2.272	1.67 3.09
4	MM 367 Station 39+00	Surface Base	1.1 2.1	2.182 2.291	1.87 3.70
5	MM 369 Station 39+00	Surface Binder Base	1.0 1.6 1.4	2.245 2.320 2.377	1.59 2.03 0.50
6	MM 372 Station 14+00	Surface Base	1.1 2.2	2.212 2.304	1.95 1.36
7	MM 373 Station 37+00	Surface Base	1.4 2.0	2.196 2.342	4.22 1.07
8	MM 374 Station 36+00	Surface Base	1.3 2.3	2.148 2.346	4.08 2.93

Group 1 - Cores 1 and 2
Group 2 - Cores 3, 4, and 5
Group 3 - Cores 6, 7, and 8

Table 4
Hot Mix Asphalt Properties
Surface Course Layer
Blue Ridge Parkway - Section 2P
Asheville, North Carolina

	Group 1	**Group 2**	**Group 3**
Sieve Size	**Percent Passing**		
½ in.	100.0	100.0	100.0
3/8 in.	95.2	91.9	95.3
No. 4	63.9	50.3	53.5
No. 8	48.1	23.2	23.5
No. 16	37.7	14.6	13.3
No. 30	29.1	11.9	10.4
No. 50	20.0	9.8	8.4
No. 200	5.8	4.7	3.8
Asphalt Content (%)	5.9	5.6	5.5
Absolute Viscosity (poise)	37,612	198,644	319,342

Note: Composite Samples - Cores trimmed and combined

Group 1 =	MM 360	Station 24 + 00
	MM 361	Station 51 + 00
Group 2 =	MM 365	Station 11 + 00
	MM 367	Station 39 + 00
	MM 369	Station 39 + 00
Group 3 =	MM 372	Station 14 + 00
	MM 373	Station 37 + 00
	MM 374	Station 36 + 00

Table 5
Hot Mix Asphalt Properties
Binder/Base Course Layer
Blue Ridge Parkway - Section 2P
Asheville, North Carolina

	Group 1	**Group 2**	**Group 3**
Sieve Size	**Percent Passing**		
1 in.	100.0	100.0	100.0
3/4 in.	97.6	97.8	99.5
½ in.	78.6	86.1	83.6
3/8 in.	66.6	72.4	71.9
No. 4	45.4	51.7	54.5
No. 8	36.4	36.7	42.8
No. 16	30.1	28.0	33.4
No. 30	23.9	21.5	25.3
No. 50	16.3	14.2	16.5
No. 200	4.7	5.3	6.2
Asphalt Content (%)	5.1	4.9	5.0
Absolute Viscosity (poise)	32,516	283,912	215,887

Note: Composite Samples - Cores trimmed and combined

Group 1 =	MM 360	Station 24 + 00
	MM 361	Station 51 + 00
Group 2 =	MM 365	Station 11 + 00
	MM 367	Station 39 + 00
	MM 369	Station 39 + 00
Group 3 =	MM 372	Station 14 + 00
	MM 373	Station 37 + 00
	MM 374	Station 36 + 00

Appendix F

FWD Testing

CONSULTANTS
A Division of Applied Research Associates, Inc.

ARA-TR-03-16062

BLUE RIDGE PARKWAY

STRUCTURAL ANALYSIS AND OVERLAY DESIGN SECTION 2P

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October 2003

Final Report

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TABLE OF CONTENTS

Chapter **Page**

1 BACKGROUND 1

2 FALLING WEIGHT DEFLECTOMETER 2
2.1 GENERAL 2
2.2 RESULTS AND ANALYSIS 3
2.2.1 Pavement Layer Thickness 3
2.2.2 Depth to Stiff Layer 5
2.2.3 Layer Moduli of the Parkway 7
2.2.4 Layer Moduli of the Pull-Offs and Parking Areas 9

3 STRUCTURAL ANALYSIS 10
3.1 DESIGN STRUCTURAL NUMBER 10
3.2 EFFECTIVE STRUCTURAL NUMBER 11

4 PAVEMENT REHABILITATION RECOMMENDATIONS 13
4.1 STRUCTURAL OVERLAY 13
4.2 COMPLETE RECONSTRUCTION 13

Appendix **Page**

A FALLING WEIGHT DEFLECTOMETER TEST LOCATIONS A-1

LIST OF FIGURES

Figure **Page**

1 Typical FWD 2
2 Schematic of FWD....2
3 Pavement thickness determined from cores....4
4 Deflection characteristics in the vicinity of the 7-inch core 5
5 Relationship between overall basin RMS and percent error on 60-inch sensor 6
6 Hogg model calculated depth to bedrock....7
7 FWD sensor deflection by station....8

LIST OF TABLES

Table		Page
1	Thickness of cores from pull-offs and parking areas	4
2	Calculated layer moduli	7
3	Average layer moduli and deflections by analysis segment	8
4	15th percentile layer moduli by analysis segment	9
5	Backcalculation results for pull-offs and parking lots	9
6	Traffic data	10
7	Required structural numbers	10
8	Effective structural numbers for section 2P	11
9	Effective structural numbers for parking areas and pull-offs	12
10	Required overlay thicknesses	13
11	Minimum reconstructed pavement layer thicknesses	14

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1 BACKGROUND

The Blue Ridge Parkway is a two-lane asphalt concrete (AC) roadway. ARCADIS G&M, Inc., is responsible for preparation of plans, specifications, and estimates for resurfacing and rehabilitation of the parkway, pull offs and parking areas from Milepost 359.8 to Milepost 375.3, known as section 2P. The role of ERES Consultants, a Division of Applied Research Associates, is to provide pavement analysis and rehabilitation recommendations. Specific tasks include:

- Non-destructive testing of the parkway pavement by falling weight deflectometer (FWD)
- Structural analysis by the American Association of State Highway and Transportation Officials (AASHTO) structural number method outlined in the 1993 AASHTO Design Guide
- Recommendations for rehabilitation, including design overlay thickness if required.

2 FALLING WEIGHT DEFLECTOMETER

2.1 GENERAL

The FWD is a rapid, nondestructive test method, which causes minimal interruption to traffic and causes essentially no damage to the pavements. Figure 1 is a photo of a typical FWD device. A schematic of an FWD system is shown in Figure 2. FWD tests require less than two minutes, and can be performed any time of day or night.

Figure 1. Typical FWD.

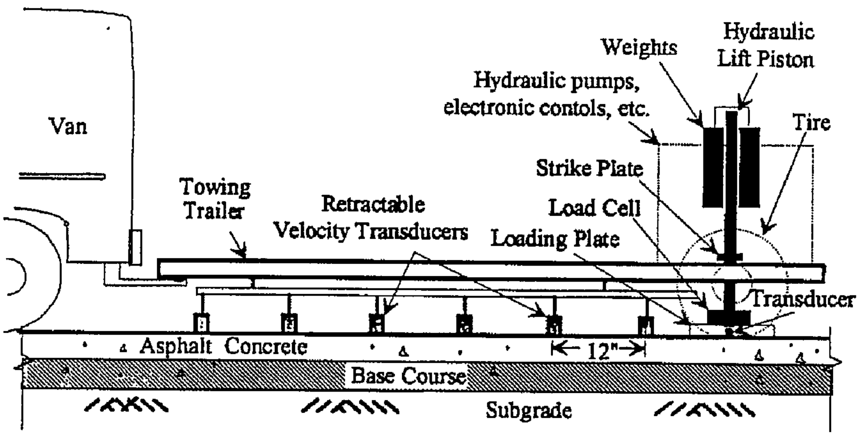

Figure 2. Schematic of FWD.

FWD testing involves subjecting a pavement to an impulse load and measuring the resulting deflection basin. The shape and magnitude of the deflection basin are used to analytically determine the moduli of the pavement and subgrade using software packages such as EverCalc or WESDEF. These properties are in turn used to determine the structural support capability of the pavement using a pavement design method such as the AASHTO method. The properties can then be used to analytically estimate the pavement load capacity and remaining life of the pavement using a limiting stress/strain analysis.

The program EverCalc was used to backcalculate the layer moduli from the deflection data. Backcalculation requires that a pavement model be input into the program. The model defines the number of layers, the thickness of each of the layers, plus the initial moduli for each layer, the moduli range and Poisson's ratio for each of the layers. Once the pavement model has been defined, EverCalc calculates a set of deflections based on the model and compares the calculated deflections to the measured deflections. EverCalc then adjusts the moduli based on the differences between the calculated and measured deflections and recalculates a new set of deflections. This process is continued until the calculated deflections and measured deflections are within the user input tolerance, the moduli did not change within the user input tolerance, or the number of iterations exceeds the limit input by the user.

2.2 RESULTS AND ANALYSIS

FWD testing was conducted at nominal ¼-mile intervals in both the northbound and southbound lanes. Test points in the northbound lane were offset from test points in the southbound lanes to provide an overall test point spacing of approximately 1/8 of a mile (approximately 700 feet). There were 130 test locations on the parkway. Some data were not useable due to subgrade conditions or interference from traffic; these data were discarded.

Data were collected at ten selected locations in pull-offs and parking areas adjacent to section 2P. The adjacent pavements that were tested are:

- Balsam Gap Overlook
- Bull Creek Overlook
- Craggy Dome Overlook (two test locations)
- Lane Pinnacle Overlook
- Picnic area parking (two tests)
- Picnic area access road (two test locations)
- Visitor Center parking

The second test in the picnic parking area was discarded because the deflection basin was improperly shaped. The shape of the discarded basin and magnitude of the deflections was consistent with extremely weak pavement and subgrade.

2.2.1 Pavement Layer Thickness

No data were available concerning base layers. A base layer thickness of 12 inches was initially assumed for all test points. Results of the backcalculation analysis later showed this assumption to be false; however, the results of the backcalculation analysis are considered correct because the software treated the layer as an additional layer of subgrade.

Cores were taken for AC thickness determination at 34 locations in section 2P. Eighteen cores were from the southbound lane (SB), 15 cores were from the northbound lane (NB), and one core with no lane designation. The AC thicknesses determined from the cores is shown in Figure 3. Six cores were taken in the pull-offs and parking areas adjacent to the parkway: two in the picnic area access road, one in the picnic area, one in the visitor center parking lot, and two at Craggy Dome. Core thicknesses for pull-off and parking area pavements are given in Table 1.

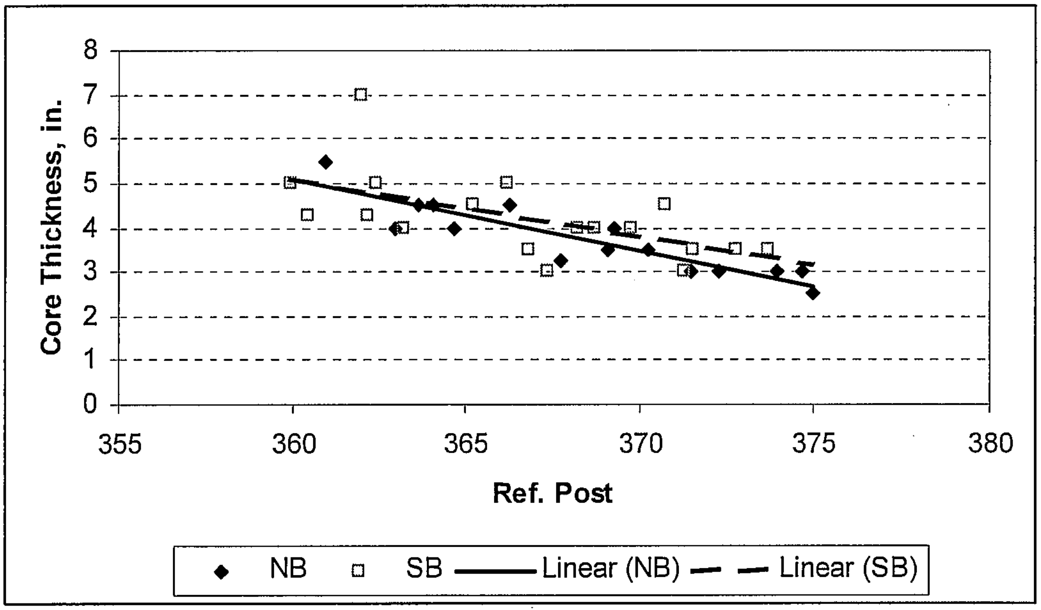

Figure 3. Pavement thickness determined from cores.

Table 1. Thickness of cores from pull-offs and parking areas.

Core Location	Core Thickness (inch)
Picnic Area Access Road sta 20+50	3.5
Picnic Area Access Road sta 36+80	4.5
Picnic Area Parking	2.0
Visitor Center Parking	3.0
Upper Craggy Dome	2.5
Lower Craggy Dome	2.5

Thickness of the AC layer must be determined at each test point to analyze deflection data by backcalculation. Typically, this is done by selecting a representative thickness for specific sections, or by interpolating the thickness for test points located between cores. Pavement thickness for pull-offs and parking lots was taken as the thickness of the core nearest the test point.

The thickness plot for the parkway shows a general trend of the AC decreasing in thickness from about 5 inches thick at the beginning of the section to about 3 inches thick at the end, with no areas of uniform thickness. For this analysis, a linear regression model was used to determine the thickness of the AC layer at each test point because of the variability between the cores and the long distances between the cores. The model was checked for validity by comparing predicted thicknesses to known thicknesses at locations where cores were taken. The average absolute difference between the predicted thickness and the measured thickness is 0.3 inches for the northbound cores and 0.5 inches for the southbound cores. This is an extremely accurate model, given that actual pavement thicknesses can change over distances as small as two to three feet.

The higher average absolute difference for the southbound cores is likely the seven-inch core at reference post 361 plus 51+00. To determine if that core indicates thicker pavement near where the core was taken, a plot of deflection results near the core (Figure 4) was evaluated. The plot shows one test point at reference post 362 plus 10+50 to have greater pavement stiffness according to the Area Basin Factor, which is related to the area under a plotted deflection basin curve. There was no trend in increased strength around Reference Post 362, the location of the 7-inch core. The 7-inch core was then considered an isolated condition.

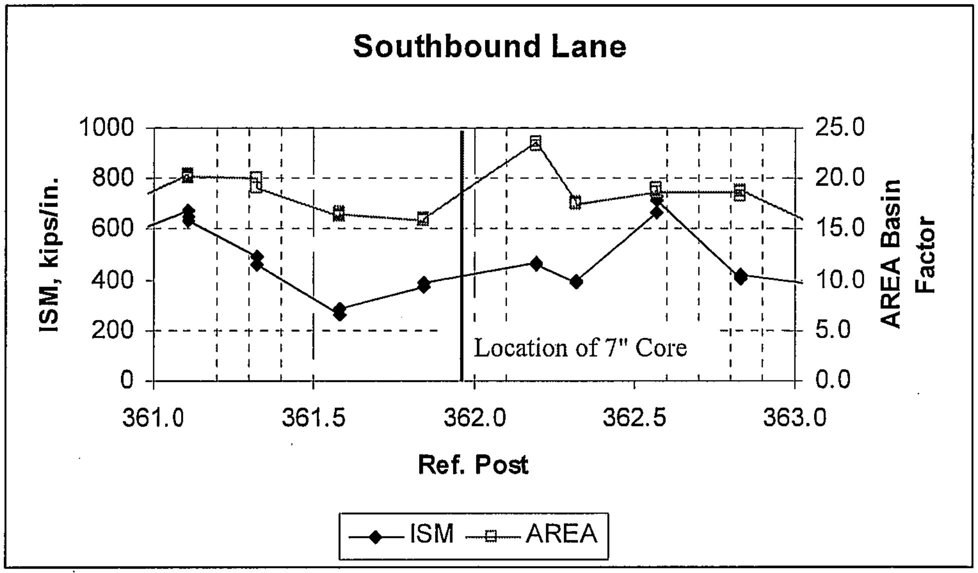

Figure 4. Deflection characteristics in the vicinity of the 7-inch core.

2.2.2 Depth to Stiff Layer

The presence of an underlying 'apparent stiff layer' such as bedrock will have an influence on the measured deflections. The EverCalc backcalculation software was selected for its ability to estimate the depth of the apparent stiff layer. The estimation process uses the thickness of the bound layer and deflection basin characteristics as input.

In our experience, the algorithms used by EverCalc tend to underestimate the depth to the apparent stiff layer when the pavement is in poor condition. Underestimating the depth to the apparent stiff layer results in lower backcalculated subgrade moduli. The low subgrade moduli, in turn, results in surface or base moduli that are too high. This results in backcalculation models that do not match measured deflection basins, as evidenced by high root mean square (RMS) errors. The RMS is a measure of agreement between the measured and calculated deflection basin. In these cases, much of the RMS error is due to large differences between the measured and calculated deflections for the outer sensors. The RMS error for this dataset is 26% when the EverCalc depth-to-bedrock model is used. Figure 5 shows that the RMS error is closely related to the percent error of the outer sensor deflection for this dataset, meaning it is likely that EverCalc is underestimating the depth of bedrock for much of the data. However, if the model predicts near-surface bedrock, e.g., a stiff layer at depths of less than five feet, it is likely that such a layer exists. The existence of near-surface bedrock predicted by the model can be confirmed by examination of outer sensor data. If outer sensor deflections are less than one mil, it is very likely the pavement is above near-surface bedrock. Several of the test points have deflections close to zero, a definite indicator that a very stiff layer is close to the surface.

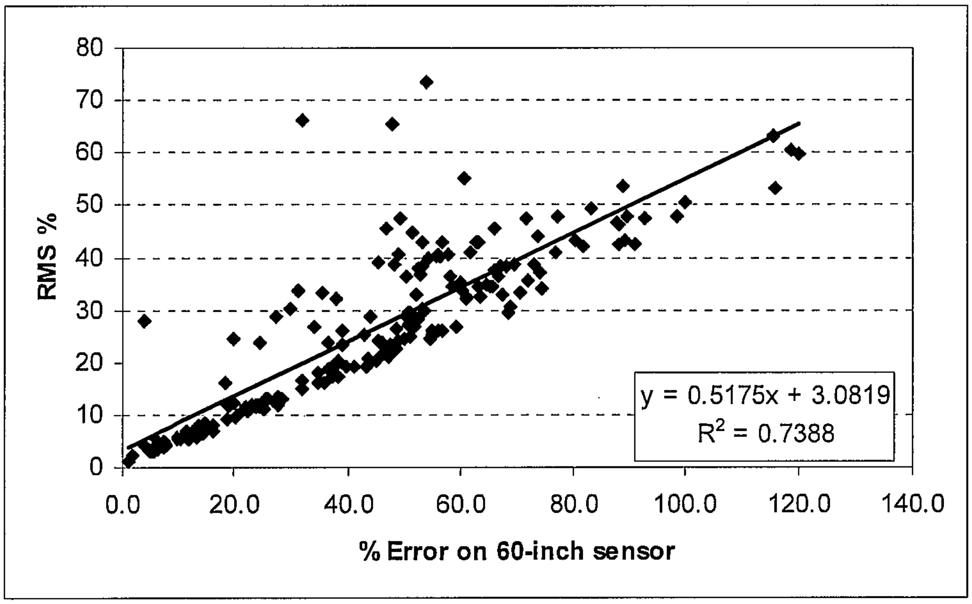

Figure 5. Relationship between overall basin RMS and percent error on 60-inch sensor.

The Hogg model was also used to calculate the subgrade thickness. The Hogg model sets the depth to the apparent stiff layer at 10 times the characteristic length. The characteristic length is calculated from the deflection basin and is related to the depth at which significant deflection no longer occurs. After the subgrade thicknesses were determined by the Hogg model, a backcalculation analysis was performed with subgrade thicknesses based on the results. The backcalculation results are an improvement over the EverCalc calculated depth to stiff layer, with a total RMS error of 18%.

The depth to bedrock estimate on the pull-offs and parking lots was further refined by multiplying the original estimate by the error of the outer deflection sensor and performing the backcalculation again. This method was able to reduce RMS error to less than 10% for six of the nine test locations.

The calculated depth to bedrock on the parkway ranged from 2 to 12 feet, as shown in Figure 6. The depth to bedrock is approximately eight to ten feet at mile 359, and steadily decreases until mile 365. Bedrock is generally found at a depth of four to seven feet between miles 365 and 375. The calculated depth to bedrock on parking lots and pull-offs ranges from 5.5 feet to 8 feet, with the exception of the picnic area access road, which has a calculated depth to bedrock of 16.5 feet at station 19+98 and 13 feet at station 40+00.

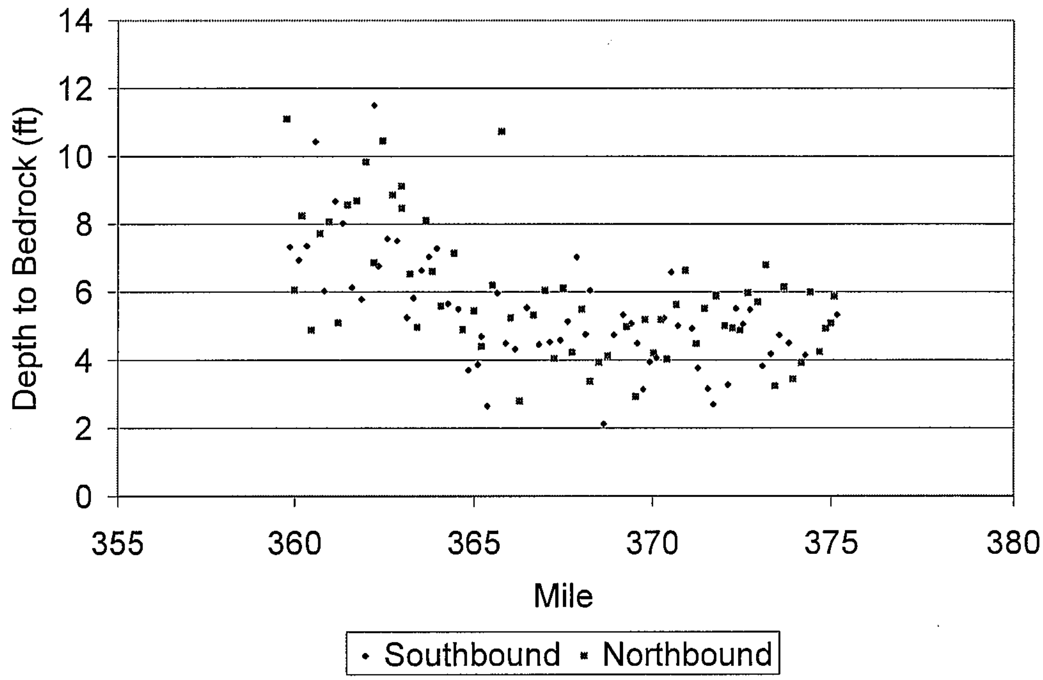

Figure 6. Hogg model calculated depth to bedrock.

2.2.3 Layer Moduli of the Parkway

The average calculated layer moduli for the parkway data points are shown in Table 2, along with the maximum, minimum, and standard deviation for each layer. The AC and base layer moduli maximum and minimum values are the limits set during the analysis, indicating that the model used in backcalculation was not the most accurate model. The most likely source of error in the model is the base thickness, which was assumed to be 12 inches thick in lieu of base thickness data.

Table 2. Calculated layer moduli.

	AC Modulus (ksi)	Base Modulus (ksi)	Subgrade Modulus (ksi)
Average	392	26	14
Minimum	75	5	3
Maximum	1500	150	50
Standard Deviation	357	22	10

Section 2P was divided into five segments for structural analysis based on the deflection plot, shown in Figure 7. The outer (60-inch) sensor deflection, which is most affected by subgrade conditions, varies considerably, from approximately 0.1 mils to 7 mils. The large variation indicates that bedrock is near the surface in some areas and is covered by a comparatively soft material in other areas. Segment 3 has consistently higher outer sensor deflections than the rest of the area of interest, indicating that larger overall deflections in this area may be caused by the subgrade. The outer sensor deflections in segment 5 are similar to the outer sensor deflections of the other segments, indicating the larger overall deflections in this area are caused by the upper layers. Table 3 shows the average 0-inch offset (inner) and 60-inch offset (outer) sensor deflection and average layer moduli for each analysis segment. Moduli from the backcalculation analysis were not multiplied by the 0.33 factor recommended in the

1993 AASHTO design guide due to the limited depth to bedrock. Shallow bedrock produces lower moduli in backcalculation analyses; therefore, it is more appropriate to use a 15th percentile value in this situation. Table 4 shows the 15th percentile modulus of each layer. As shown in Tables 3 and 4, the backcalculation results show that the assumed 12-inch base layer has approximately the same modulus as the underlying subgrade, indicating that the assumed base is not present. The modulus of the base of Segment 4 was approximately double the modulus of the subgrade, indicating that some sort of base material is present. The thickness of the base material in Segment 4 is unknown.

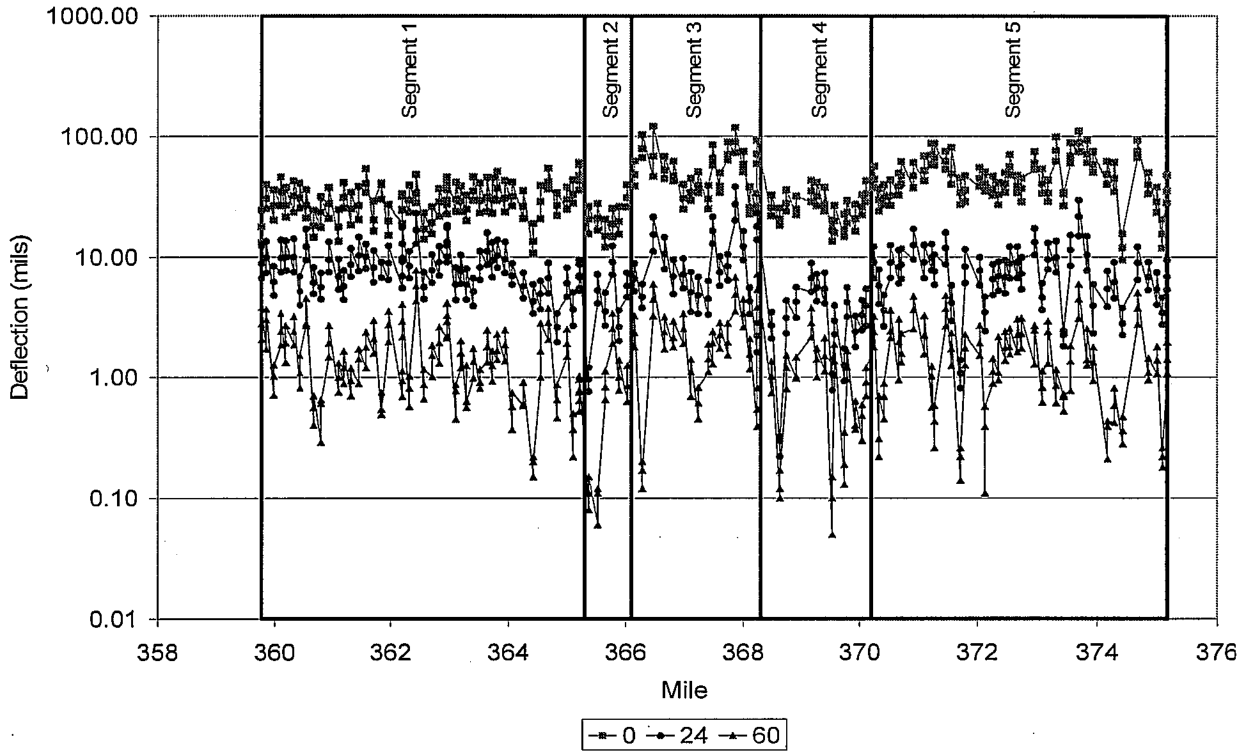

Figure 7. FWD sensor deflection by station.

Table 3. Average layer moduli and deflections by analysis segment.

	Mile									
	Segment 1 359.7 to 365.3		Segment 2 365.3 to 366.1		Segment 3 366.1 to 368.3		Segment 4 368.3 to 370.2		Segment 5 370.2 to 375.17	
	Average	Std Dev	Average	Std Dev	Average	Std Dev	Average	Std Dev	Average	Std Dev
Inner Sensor Defl. (mils)	30.37	10.08	21.88	6.98	54.71	24.23	26.21	7.54	48.04	19.75
Outer Sensor Defl. (mils)	1.65	1.18	0.94	0.92	2.36	1.65	1.02	0.79	1.62	1.17
AC Modulus (ksi)	485.88	371.42	643.74	552.39	169.11	93.13	324.58	267.68	360.23	346.24
Base Modulus (ksi)	19.02	11.84	28.05	15.19	30.55	20.60	51.14	31.98	24.51	21.07
Subgrade Modulus (ksi)	13.42	5.92	25.14	13.90	10.17	6.71	23.58	13.95	11.89	8.55

Table 4. 15th percentile layer moduli by analysis segment.

Segment	1	2	3	4	5
Mile	359.7 to 365.3	365.3 to 366.1	366.1 to 368.3	368.3 to 370.2	370.2 to 375.17
AC Modulus (ksi)	149.36	185.46	90.04	161.86	141.82
Base Modulus (ksi)	8.58	10.18	9.39	24.98	8.23
Subgrade Modulus (ksi)	8.74	12.58	4.14	13.17	6.02

2.2.4 Layer Moduli of the Pull-Offs and Parking Areas

Each data point for the pull-offs and parking areas was analyzed separately because five of the seven pavements had a single test point, and the test points in the remaining parking areas were widely spaced. Analysis of an individual deflection test is highly sensitive to model inputs, because the tools to detect and eliminate outliers by comparison to other tests from pavements with similar structure are not available. Analyses of thin pavements are particularly sensitive, requiring large changes in estimated modulus to accommodate small changes in pavement thickness and deflection. Backcalculation results of the pull-offs and parking areas are shown in Table 5.

Table 5. Backcalculation results for pull-offs and parking areas.

	Balsam Gap		Bull Creek		Upper Craggy Dome		Lower Craggy Dome		Lane Pinnacle		Picnic Area Parking		Picnic Access Road sta 19+98		Picnic Access Road sta 40+00		Visitor Center Parking	
	E ksi	T in.	E ksi	T in.	E ksi	T in.	E ksi	T in.	E ksi	T in.	E ksi	T in.	E ksi	T in.	E ksi	T in.	E ksi	T in.
AC	330	3*	103	3*	446	2.5	316	2.5	-	-	-	2	381	3.5	924	4.5	270	2
Base	13.6	12	18.6	12	5.5	12	5.0	12	-	-	-	12	5.0	8	8.7	8	19.6	12
Subgrade	5.7	90	12.5	72	6.4	83	5.1	88	20.0	67	5.0	98	2.5	197	3.5	156	5.8	77

* estimated AC thickness

AC layer moduli appear reasonable, with the exception of the picnic access road, which is extremely stiff. The backcalculated moduli of the pull-offs and parking areas are generally consistent with the backcalculation result for the Parkway. The backcalculation process was unable to determine acceptable AC and base layer moduli for the picnic parking area and Lane Pinnacle pull-off, most likely due to the estimated layer thicknesses. Note that the AC thickness was not available for Balsam Gap, Bull Creek, and Lane Pinnacle; the values given are estimates that yield the best backcalculation results. Given the similarity to the parkway results, the estimated base layer thickness, the sensitivity to layer thickness, and the lack of statistical validation, we recommend using a typical modulus of 150 ksi for the existing AC layers.

3 STRUCTURAL ANALYSIS

3.1 DESIGN STRUCTURAL NUMBER

The AASHTO design method was used for structural analysis. The traffic data in Table 6 was provided by ARCADIS. A structural number of 3 and a 4% growth rate for a 20-year design life with a terminal serviceability of 2.5 was assumed for traffic calculations. The design ESAL for this traffic mix is approximately 208,000 ESALs. A design ESAL of 208,000 ESALs is recommended. To estimate traffic levels for pull-offs and parking lots, it was assumed that 50% of traffic on the parkway would stop at any given pull-off. This gives a design ESAL of 104,000 ESALs for parking lots and pull-offs.

Table 6. Traffic data.

Vehicle	Axle Weight/Type	Current Daily Volume	Growth Factor	Design Load	ESAL Factor	Design ESAL
Passenger Cars	2-kip/single	3,700	29.78	40,217,890	0.0003	12,066
Travel Trailer	14-kip/tandem	100	29.78	1,086,970	0.0420	45,653
Recreational Vehicles	10-kip/single	100	29.78	1,086,970	0.1180	128,262
Construction Vehicles	18-kip/single	2	29.78	21,740	1.0000	21,740
					Total	**207,721**

Reliability, a statistical degree of certainty, was obtained from Part II Table 2.2 of the AASHTO design guide. The Blue Ridge Parkway falls into the functional class of a rural freeway. A reliability of 95% was selected. The AASHTO recommended standard deviation of 0.35 for flexible pavements was selected. The initial serviceability of the parkway was assumed to be 4.6. The terminal serviceability of 2.0 was selected because the road is a tourist attraction, yielding a drop in serviceability of 4.6-2.5=2.1 points. Parking lots and pull-offs were assumed to have a terminal serviceability of 2.0, yielding a serviceability drop of 4.6-2.0=2.6 points. The 15th percentile subgrade moduli shown in Table 3 were used for roadbed modulus values for the parkway. The subgrade moduli listed in Table 4 were used for roadbed moduli for the parking lots and pull-offs. The required structural number for each segment as determined from Part II Figure 3.1 of the AASHTO design guide is shown in Table 7.

Table 7. Required structural numbers.

Segment	Roadbed Modulus (ksi)	Required SN
1	9	2.46
2	13	2.14
3	4	3.29
4	13	2.14
5	6	2.85
Balsam Gap	5.7	2.56
Bull Creek	12.5	1.92
Craggy Dome	5.8	2.55
Lane Pinnacle	20.0	1.60
Picnic Parking	5.0	2.67
Picnic Access	3.0	3.28
Visitor Center	5.8	2.54

3.2 EFFECTIVE STRUCTURAL NUMBER

Effective structure number was determined from the known layer thicknesses and moduli. Structural number is determined by the equation $SN = a_1 D_1 + a_2 D_2$ where a_1 and a_2 are structural layer coefficients and D_1 and D_2 are the layer thicknesses of the AC and base, respectively. The structural layer coefficient a_1 was determined from Part II Figure 2.5 of the AASHTO design guide using the 15th percentile AC layer modulus from Tables 4 and 5. The structural layer coefficient a_2 was determined from Part II Figure 2.6 of the AASHTO design guide using the 15th percentile base layer modulus from Tables 4 and 5. The average AC thickness of each analysis segment was determined from the thickness values used in the backcalculation results. Base thickness was assumed to be 12 inches when present. Table 12 summarizes the effective structural number calculations.

Table 8. Effective structural numbers for Section 2P.

Segment 1				
Layer	E (ksi)	a	Thickness (in)	aD
AC	149	.25	4.6	1.15
Base	-	-	-	
			Structural Number	**1.15**
Segment 2				
Layer	E (ksi)	a	Thickness (in)	aD
AC	185	.275	4.1	1.13
Base	-	-	-	-
			Structural Number	**1.13**
Segment 3				
Layer	E (ksi)	a	Thickness (in)	aD
AC	90	.2	3.9	0.78
Base	9	.03	12	0.36
			Structural Number	**1.14**
Segment 4				
Layer	E (ksi)	a	Thickness (in)	aD
AC	161	.25	3.6	0.90
Base	25	.12	12	0.36
			Structural Number	**1.26**
Segment 5				
Layer	E (ksi)	a	Thickness (in)	aD
AC	141	.25	3.0	0.75
Base	-	-	-	-
			Structural Number	**0.75**

* estimated AC thickness

Table 9. Effective structural numbers for parking areas and pull-offs.

Balsam Gap				
Layer	E (ksi)	a	Thickness (in)	aD
AC	150	.25	3.0*	0.75
Base	13.6	.06	12	0.72
			Structural Number	**1.47**
Bull Creek				
Layer	E (ksi)	a	Thickness (in)	aD
AC	150	.25	3.0*	0.75
Base	18.6	.09	12	1.08
			Structural Number	**1.83**
Craggy Dome				
Layer	E (ksi)	a	Thickness (in)	aD
AC	150	.25	2.5	0.63
Base	-	-	-	-
			Structural Number	**0.63**
Lane Pinnacle				
Layer	E (ksi)	a	Thickness (in)	AD
AC	150	.25	2.0*	0.50
Base	-	-	-	-
			Structural Number	**0.50**
Picnic Area Parking				
Layer	E (ksi)	a	Thickness (in)	aD
AC	150	.25	2.0	0.50
Base	-	-	-	-
			Structural Number	**0.50**
Picnic Area Access Road				
Layer	E (ksi)	a	Thickness (in)	aD
AC	150	.25	4.0	1.00
Base	-	-	-	-
			Structural Number	**1.00**
Visitor Center				
Layer	E (ksi)	a	Thickness (in)	aD
AC	150	.25	2.0	0.50
Base	19.6	.09	12	1.08
			Structural Number	**1.58**

* estimated AC thickness

\- no base layer

4 PAVEMENT REHABILITATION RECOMMENDATIONS

Structural analysis results indicate that the pavement is structurally deficient. These results are supported by the presence of scattered fatigue cracking and rutting. A structural enhancement is required. Two rehabilitation methods were examined:

- Structural overlay
- Complete reconstruction.

New AC material was assumed to be dense-graded material with a layer coefficient of 0.42, which corresponds to a modulus of 400 ksi for new pavement. New base materials are assumed to have a CBR of 80, which corresponds to a layer coefficient of 0.13.

4.1 STRUCTURAL OVERLAY

A structural overlay should be preceded by milling a minimum one-inch layer from the existing pavement. Milling operations should completely remove the surface course of the existing pavement, but leave a minimum 1.5" layer of AC above the subgrade. If either criterion cannot be met, the pavement should be completely reconstructed. Areas with moderate to severe fatigue cracking should be repaired with a full depth patch prior to being overlaid. Table 10 summarizes the minimum required overlay thicknesses for each analysis segment, rounded up to the nearest ½-inch.

Table 10. Required overlay thicknesses.

Segment	Existing AC (inch)	Effective SN	Required SN	Recommended Overlay (inch)
1	4.6	1.51	2.46	3.5
2	4.1	1.49	2.14	2.5
3	3.9	1.14	3.29	5.5
4	3.6	1.26	2.14	2.5
5	3.0	1.11	2.85	5.0
Balsam Gap	3.0*	1.47	2.56	3.0
Bull Creek	3.0*	1.83	1.92	0.5
Craggy Dome	2.5	0.87	2.55	5.0
Lane Pinnacle	2.0*	0.50	1.60	3.0
Picnic Parking	2.0	0.50	2.67	5.5
Picnic Access	4.0	1.16	3.28	5.5
Visitor Center	2.0	1.58	2.54	2.5

* estimated AC thickness

4.2 COMPLETE RECONSTRUCTION

Complete reconstruction is removal of the pavement structure to the subgrade and placing new base and surface courses. The subgrade should be scarified, recompacted, and proof rolled. The base layer should be either crushed stone or processed recycled asphalt pavement. In-place cold recycling is not recommended due the high variability in AC thickness and quality. The base course should have a minimum CBR of 80. A recycled AC/soil mix would be acceptable for the base if the resulting material had a CBR of 80. Table 11 lists the minimum recommended pavement layer thicknesses for an unimproved subgrade. Scarification and recompaction of the subgrade may result in thinner required pavement sections based upon recompacted subgrade strengths. Base thicknesses may be increased to improve constructability if desired. The

AASHTO procedure allows AC layer thicknesses as low as 2.5 inches for the parkway and 2.0 inches for the pull-offs, however, a minimum AC thickness of 4.0 inches for the parkway and 3.5 inches for the pull offs is recommended. A minimum base thickness of six inches, instead of the minimum of four inches allowed by the AASHTO procedure, is also recommended.

Table 11. Minimum reconstructed pavement layer thicknesses.

Segment	Required SN	AC (inch)	Base (inch)
1	2.46	4.0	6
2	2.14	4.0	6
3	3.29	4.0	13
4	2.14	4.0	6
5	2.85	4.0	9
Balsam Gap	2.56	3.5	9
Bull Creek	1.92	3.5	6
Craggy Dome	2.55	3.5	9
Lane Pinnacle	1.60	3.5	6
Picnic Parking	2.67	3.5	10
Picnic Access	3.28	3.5	14
Visitor Center	2.54	3.5	9

APPENDIX A

FALLING WEIGHT DEFLECTOMETER TEST LOCATIONS

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Mile Post	Station	Lane	Mile Post	Station	Lane
359	41+00	NB	367	32+00	SB
359	45+50	SB	367	33+00	SB
359	52+00	NB	367	39+00	NB
360	6+00	SB	367	45+75	SB
360	10+50	NB	367	48+00	SB
360	17+50	SB	367	53+00	NB
360	24+00	NB	368	12+50	NB
360	26+50	NB	368	25+50	NB
360	30+00	SB	368	39+00	NB
360	43+00	SB	369	4+50	NB
360	50+00	NB	369	9+00	SB
361	6+00	SB	369	14+00	NB
361	10+50	NB	369	21+00	SB
361	17+00	SB	369	28+00	NB
361	24+00	NB	369	30+00	SB
361	30+50	SB	369	39+00	SB
361	37+50	NB	369	41+50	NB
361	44+50	SB	369	49+00	SB
361	51+00	NB	369	55+00	NB
362	10+50	NB	370	6+00	SB
362	10+50	SB	370	13+00	NB
362	17+00	SB	370	17+50	SB
362	23+00	NB	370	22+00	NB
362	30+00	SB	370	28+00	SB
362	37+50	NB	370	35+50	NB
362	44+00	SB	370	38+00	SB
362	50+95	NB	370	49+00	NB
362	51+00	NB	371	6+00	SB
363	6+00	SB	371	12+46	NB
363	10+50	NB	371	15+00	SB
363	15+50	SB	371	25+00	NB
363	21+50	NB	371	30+00	SB
363	27+50	SB	371	38+00	SB
363	34+02	NB	371	42+00	NB
363	38+50	SB	371/372	55+08/0+00	NB
363	43+00	NB	372	7+00	SB
363	50+00	SB	372	14+00	NB
364	3+50	NB	372	19+00	SB
364	13+51	SB	372	24+83	NB
364	29+00	SB	372	29+00	SB
364	32+50	NB	372	35+96	NB
364	35+96	NB	372	39+50	SB
364	44+00	SB	372	51+00	NB
365	0+00	NB	373	5+00	SB
365	5+50	SB	373	10+00	NB
365	11+00	NB	373	17+00	SB
365	11+00	SB	373	23+50	NB
365	19+50	SB	373	29+50	SB
365	27+50	NB	373	36+83	NB

Mile Post	Station	Lane	Mile Post	Station	Lane
365	34+50	SB	373	44+00	SB
365	41+00	NB	373	49+52	NB
365	47+00	SB	374	2+50	SB
366	1+50	NB	374	8+87	NB
366	8+00	SB	374	15+00	SB
366	15+00	NB	374	22+40	NB
366	25+04	SB	374	28+50	SB
366	35+00	NB	374	35+87	NB
366	43+00	SB	374	41+00	SB
366	52+00	NB	374	45+26	NB
367	6+00	SB	375	0+00	NB
367	12+50	NB	375	2+50	SB
367	12+50	SB	375	4+81	NB
367	21+50	SB	375	5+00	SB
367	25+00	NB	375	9+00	SB
Picnic Road	19+98		Craggy Dome	Upper	
Picnic Road	40+00		Craggy Dome	Lower	
Picnic Parking	Test 1		Balsam Gap		
Picnic Parking	Test 2		Lane Pinnacle		
Visitor Center	Test 1		Bull Creek		

Appendix G

Laboratory Test Results

LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
359	52+00	Right	5	1	28.8	46	31	15	50.4	ML/A-7-6
				2	21.6	33	27	6	34.9	SM/A-2-4
360	24+00	Right	4.25	Asphalt Core Only						
360	50+00	Left	5.5	1 (3)	67.9	65	NP	NP	61.5	ML/A-7-6
				2	15.8	32	NP	NP	29.3	SM/A-2-4
361	51+00	Right	7	1	10.7	------	------	------	26.7	SM/A-2-4
362	10+50	Right	4.25	1	4.5	------	------	------	------	SM/A-2-4
				2	No Sample					
362	23+00	Right	5	1	26.0	------	------	------	37.7	SM/A-4
				2	32.9	------	------	------	------	SM/A-4
362	51+00	Left	4	1	7.3	------	------	------	------	SM/A-2-4
				2	9.7	------	------	------	------	SM/A-2-4
363	10+50	Right	4	1	11.1	33	NP	NP	28.1	SM/A-2-4
				2	11.8	------	------	------	------	SM/A-2-4

Note: (1) Measurements determined in field by Arcadis.
(2) Most soil samples contained significant amount of rock fragments.
(3) Material contains significant amount of mica.

LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
363	34+00	Left	4.5	1	17.8	------	------	------	24.4	SM/A-2-4
				2	10.4	------	------	------	------	SM/A-2-4
364	3+50	Left	4.5	1	2.8	------	------	------	------	SM/A-2-4
364	36+00	Left	4	1	11.1	------	------	------	------	SM/A-2-4
				2	5.0	------	------	------	------	SM/A-2-4
365	11+00	Right	4.5	1	22.2	------	------	------	32.3	SM/A-2-4
				2	10.3	------	------	------	------	SM/A-2-4
366	11+00	Right	5	1	14.6	------	------	------	------	SM/A-2-4
				2	12.8	34	NP	NP	24.1	SM/A-2-4
366	15+00	Left	4.5	1	9.1	------	------	------	------	SM/A-2-4
366	43+00	Right	3.5	1	5.5	------	------	------	------	SM/A-2-4
				2	4.2	------	------	------	------	SM/A-2-4
367	21+50	Right	3	No Samples						
367	39+00	Left	3.25	1	11.1	------	------	------	28.0	SM/A-2-4
				2	9.9	------	------	------	22.4	SM/A-2-4

LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
371	15+00	Right	3	1	11.3	------	------	------	23.1	SM/A-2-4
				2	14.9	------	------	------	------	SM/A-2-4
371	25+00	Left	3	1	10.9	------	------	------	27.2	SM/A-2-4
				2	28.3	------	------	------	46.3	SM/A-4
371	30+00	Right	3.5	1	11.3	------	------	------	22.7	SM/A-2-4
				2	6.7	------	------	------	------	SM/A-2-4
372	14+00	Left	3	1	17.9	25	24	1	37.8	SM/A-4
372	39+50	Right	3.5	1	12.6	------	------	------	17.7	SM/A-2-4
				2	18.0	------	------	------	32.6	SM/A-2-4
373	17+00	- - -	3.25	1	13.4	------	------	------	32.1	SM/A-2-4
373	37+00	Right	3.5	1	19.3	------	------	------	50.4	ML/A-4
				2	21.2	------	------	------	40.6	SM/A-4

LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			% Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
373	49+50	Left	3	1	16.6	33	31	2	39.6	SM/A-4
				2	7.0	------	------	------	------	SM/A-2-4
374	36+00	Left	3	1	19.7	34	NP	NP	40.3	SM/A-4
				2	3.1	------	------	------	------	SM/A-2-4
375	0+00	Left	2.5	1	14.2	29	24	5	48.2	SM/A-4
				2	0.9	------	------	------	------	SM/A-2-4
PA	20+50	Left	3.5	1	7.9	------	------	------	------	SM/A-2-4
				2	20.0	------	------	------	------	SM/A-2-4
PA	36+80	Left	4.5	1	27.4	------	------	------	33.2	SM/A-2-4
				2	27.8	------	------	------	------	SM/A-2-4
Picnic Area			2	1	8.7	------	------	------	23.2	SM/A-2-4
				2	4.9	------	------	------	------	SM/A-2-4

LABORATORY TEST DATA SUMMARY - SUBGRADE SOILS
BLUE RIDGE PARKWAY - SECTION 2P
ASHEVILLE, NORTH CAROLINA

Boring Location			Asphalt Pavement Thickness (inches) (1)	Sample Number	Water Content (%)	Atterberg Limits			%Passing No. 200 Sieve	USCS/AASHTO Classifications (2)
Mile	Station	Lane				LL	PL	PI		
Visitor Center			3	1	20.5	------	------	------	28.2	SM/A-2-4
				2	29.4	------	------	------	------	SM/A-2-4
Craggy Dome- Upper Tier			2.5	1	10.0	------	------	------	------	SM/A-2-4
				2	0.8	------	------	------	------	SM/A-2-4
Craggy Dome - Lower Tier			2.5	1	33.1	------	------	------	36.8	SM/A-2-4

Asphalt Pavement Cores
Blue Ridge Parkway - Section 2P
Asheville, North Carolina

Core No.	Core Location	Layer	Thickness (in.)	Bulk Specific Gravity	Absorption (%)
1	MM 360 Station 24+00	Surface Binder Base	1.0 1.5 2.0	Damaged 2.304 2.397	Damaged 0.98 0.36
2	MM 361 Station 51+00	Surface Binder Base	1.2 3.0 2.7	2.299 2.313 2.407	0.36 2.58 0.91
3	MM 365 Station 11+00	Surface Base	1.5 2.3	2.253 2.272	1.67 3.09
4	MM 367 Station 39+00	Surface Base	1.1 2.1	2.182 2.291	1.87 3.70
5	MM 369 Station 39+00	Surface Binder Base	1.0 1.6 1.4	2.245 2.320 2.377	1.59 2.03 0.50
6	MM 372 Station 14+00	Surface Base	1.1 2.2	2.212 2.304	1.95 1.36
7	MM 373 Station 37+00	Surface Base	1.4 2.0	2.196 2.342	4.22 1.07
8	MM 374 Station 36+00	Surface Base	1.3 2.3	2.148 2.346	4.08 2.93

Group 1 - Cores 1 and 2
Group 2 - Cores 3, 4, and 5
Group 3 - Cores 6, 7, and 8

Hot Mix Asphalt Properties
Surface Course Layer
Blue Ridge Parkway - Section 2P
Asheville, North Carolina

	Group 1	Group 2	Group 3
Sieve Size	**Percent Passing**		
½ in.	100.0	100.0	100.0
3/8 in.	95.2	91.9	95.3
No. 4	63.9	50.3	53.5
No. 8	48.1	23.2	23.5
No. 16	37.7	14.6	13.3
No. 30	29.1	11.9	10.4
No. 50	20.0	9.8	8.4
No. 200	5.8	4.7	3.8
Asphalt Content (%)	5.9	5.6	5.5
Absolute Viscosity (poise)	37,612	198,644	319,342

Note: Composite Samples - Cores trimmed and combined

Group 1 =	MM 360	Station 24 + 00
	MM 361	Station 51 + 00
Group 2 =	MM 365	Station 11 + 00
	MM 367	Station 39 + 00
	MM 369	Station 39 + 00
Group 3 =	MM 372	Station 14 + 00
	MM 373	Station 37 + 00
	MM 374	Station 36 + 00

Hot Mix Asphalt Properties
Binder/Base Course Layer
Blue Ridge Parkway - Section 2P
Asheville, North Carolina

	Group 1	Group 2	Group 3
Sieve Size	Percent Passing		
1 in.	100.0	100.0	100.0
3/4 in.	97.6	97.8	99.5
½ in.	78.6	86.1	83.6
3/8 in.	66.6	72.4	71.9
No. 4	45.4	51.7	54.5
No. 8	36.4	36.7	42.8
No. 16	30.1	28.0	33.4
No. 30	23.9	21.5	25.3
No. 50	16.3	14.2	16.5
No. 200	4.7	5.3	6.2
Asphalt Content (%)	5.1	4.9	5.0
Absolute Viscosity (poise)	32,516	283,912	215,887

Note: Composite Samples - Cores trimmed and combined

Group 1 =	MM 360	Station 24 + 00
	MM 361	Station 51 + 00
Group 2 =	MM 365	Station 11 + 00
	MM 367	Station 39 + 00
	MM 369	Station 39 + 00
Group 3 =	MM 372	Station 14 + 00
	MM 373	Station 37 + 00
	MM 374	Station 36 + 00

Tri-State Testing & Drilling, LLC
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Chattanooga TN 37416
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M
1210 Premier Drive, Suite 200
Chattanooga, TN 37421
Attn: Scott Manning
Project: Blue Ridge Parkway
Date: 10/25/04

REPORT OF GRAIN SIZE

		370.0	
Sieves	Dry Weight:		440.09
		% Ret.	% Pass.
3/4"	113.14	25.7	74.3
1/2"	176.87	40.2	59.8
3/8"	201.78	45.8	54.2
#4	243.01	55.2	44.8
#10	272.75	62.0	38.0
#16	288.23	65.5	34.5
#40	320.71	72.9	27.1
#100	367.78	83.6	16.4
#200	382.82	87.0	13.0

Remarks:

Copies to: Arcadis G & M

Project No.: TS:L-2042

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Client: Arcadis G & M
1210 Premier Drive, Suite 200
Chattanooga, TN 37421
Attn: Scott Manning
Project: Blue Ridge Parkway
Date: 10/25/04

REPORT OF GRAIN SIZE

373.0

Sieves	Dry Weight:		553.83
		% Ret.	% Pass.
3/4"	126.95	22.9	77.1
1/2"	197.60	35.7	64.3
3/8"	216.13	39.0	61.0
#4	261.95	47.3	52.7
#10	299.20	54.0	46.0
#16	324.45	58.6	41.4
#40	376.52	68.0	32.0
#100	459.32	82.9	17.1
#200	487.80	88.1	11.9

Remarks:

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Chattanooga, TN 37421
Attn: Scott Manning
Project: Blue Ridge Parkway
Date: 10/25/04

REPORT OF GRAIN SIZE

373.5

Sieves	Dry Weight:	% Ret.	736.20 % Pass.
3/4"	189.86	25.8	74.2
1/2"	318.17	43.2	56.8
3/8"	365.53	49.7	50.3
#4	433.26	58.9	41.1
#10	472.30	64.2	35.8
#16	495.48	67.3	32.7
#40	549.78	74.7	25.3
#100	639.09	86.8	13.2
#200	653.39	88.8	11.2

Remarks:

Copies to: Arcadis G & M

Project No.: TS:L-2044

Tri-State Testing & Drilling, LLC
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Chattanooga TN 37416
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M
1210 Premier Drive, Suite 200
Chattanooga, TN 37421
Attn: Scott Manning
Project: Blue Ridge Parkway
Date: 10/25/04

REPORT OF GRAIN SIZE

374.0

Sieves	Dry Weight:	% Ret.	446.30 % Pass.
3/4"	133.51	29.9	70.1
1/2"	205.63	46.1	53.9
3/8"	236.62	53.0	47.0
#4	268.48	60.2	39.8
#10	292.70	65.6	34.4
#16	306.81	68.7	31.3
#40	338.42	75.8	24.2
#100	383.19	85.9	14.1
#200	395.72	88.7	11.3

Remarks:

Copies to: Arcadis G & M

Project No.: TS:L-2045

Tri-State Testing & Drilling, LLC
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Chattanooga TN 37416
(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M
1210 Premier Drive, Suite 200
Chattanooga, TN 37421
Attn: Scott Manning
Project: Blue Ridge Parkway
Date: 10/25/04

REPORT OF GRAIN SIZE

Sieves	Dry Weight:	374.3 % Ret.	365.37 % Pass.
3/4"	84.34	23.1	76.9
1/2"	135.12	37.0	63.0
3/8"	169.33	46.3	53.7
#4	195.36	53.5	46.5
#10	215.38	58.9	41.1
#16	227.37	62.2	37.8
#40	253.20	69.3	30.7
#100	297.28	81.4	18.6
#200	313.07	85.7	14.3

Remarks:

Copies to: Arcadis G & M

Project No.: TS:L-2046

Tri-State Testing & Drilling, LLC
6228 Bonny Oaks Drive
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(423) 510-0110 - Fax (423) 510-0237

Client: Arcadis G & M
1210 Premier Drive, Suite 200
Chattanooga, TN 37421
Attn: Scott Manning
Project: Blue Ridge Parkway
Date: 10/25/04

REPORT OF GRAIN SIZE

375.0

Sieves	Dry Weight:		738.45
		% Ret.	% Pass.
3/4"	72.52	9.8	90.2
1/2"	165.85	22.5	77.5
3/8"	228.17	30.9	69.1
#4	332.34	45.0	55.0
#10	395.05	53.5	46.5
#16	428.70	58.1	41.9
#40	499.18	67.6	32.4
#100	610.16	82.6	17.4
#200	632.49	85.7	14.3

Remarks:

Copies to: Arcadis G & M

Project No.: TS:L-2047

Appendix H

Pavement Design Analysis

Subject: Pavement Design	Job No. CT052885.0001.00008	BY: CHKD:

Location: Blue Ridge Parkway, Section 2P
Reconstruction Sections Sta. 366, 24+10 to 368, 20+00 and
370, 2+00 to 375, 4+57 and Graggy Garden Access Road Sta. 24+00 to 28+50
Right Lane Going Downhill and 19+85 to 20+50.

Average Daily Traffic:	3702
Design Road Life:	20
Annual % Growth:	2.0%
Terminal Servicibility:	2.0
Directional Factor:	50%
Lane Distribution Factor:	1.0

Regional Factor	1.5
In-situ CBR	10.0
Existing 6" Agg. Base CBR	50.0
Design Soil Support Value	6.1
Calculated Design Structural Number:	2.4

Vehicle Class	Percent of ADT	Growth Factor	Average Initial Truck Factor	Accumulated 18-kip ESALs over Performance Period
Automobiles	94.8%	24.29737	0.0004	6225
RVs / Light Trucks	2.5%	24.29737	0.2	82078
Bus	2.5%	24.29737	0.88	361145
Heavy Maint. Truck	0.2%	24.29737	0.6	19699
Total	100.0%			4.7E+05

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Thickness (in)	Calculated SN
1	AC Surface	0.42	2.0	0.84
2	AC Base	0.34	3.0	1.02
3	Agg. Base[t]	0.11	6.0	0.66
TOTAL			11.0	2.52

[t] From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

Subject: Pavement Design	Job No. CT052885.0001.00008	BY: CHKD:

Location: Blue Ridge Parkway, Section 2P
In-Situ CBR of 10.0 Based on DCP data
Reconstruction of Craggy Dome Upper Parking, Craggy Garden Picnic Parking and Visitor Center

Average Daily Traffic:	1851
Design Road Life:	20
Annual % Growth:	2.0%
Terminal Servicibility:	2
Directional Factor:	50%
Lane Distribution Factor:	1.0

Regional Factor	1.5
In-situ CBR	10.0
Existing 6" Agg. Base CBR	50.0
Design Soil Support Value	6.1
Calculated Design Structural Number:	2

Vehicle Class	Percent of ADT	Growth Factor	Average Initial Truck Factor	Accumulated 18-kip ESALs over Performance Period
Automobiles	95.0%	24.29737	0.0004	3119
RVs / Light Trucks	3.0%	24.29737	0.2	49247
Bus	1.0%	24.29737	0.88	72229
Heavy Maint. Truck	1.0%	24.29737	0.6	49247
Total	100.0%			1.7E+05

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Thickness (in)	Calculated SN
1	AC Surface	0.42	1.5	0.63
2	AC Binder	0.34	2.5	0.85
3	Agg. Base[t]	0.11	6.0	0.66
TOTAL			10.0	2.14

[t] From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

Subject: Pavement Design	Job No. CT052885.0001.00008	BY: CHKD:

Location: Blue Ridge Parkway, Section 2P
Mill and Overlay Sections Sta. 359, 39+00 to 366, 24+10 and 368, 20+00 to 370, 2+00, and The Craggy Garden Access Road not requiring reconstruction.

Average Daily Traffic:	3702
Design Road Life:	20
Annual % Growth:	2.0%
Terminal Servicibility:	2
Directional Factor:	50%
Lane Distribution Factor:	1.0

Regional Factor	1.5
In-situ CBR	10.0
Existing 6" Agg. Base CBR	50.0
Design Soil Support Value	6.1
Calculated Design Structural Number:	2.4

Vehicle Class	Percent of ADT	Growth Factor	Average Initial Truck Factor	Accumulated 18-kip ESALs over Performance Period
Automobiles	94.8%	24.29737	0.0004	6225
RVs / Light Trucks	2.5%	24.29737	0.2	82078
Bus	2.5%	24.29737	0.88	361145
Heavy Maint. Truck	0.2%	24.29737	0.6	19699
Total	100.0%			4.7E+05

Specified Layer Design

Layer	Material Description	Struct. Coef. (Ai)	Thickness (in)	Calculated SN
1	AC Surface	0.42	1.5	0.63
2	AC Base	0.34	2.5	0.85
3	AC Base*	0.2	2.0	0.4
4	Agg. Base[t]	0.11	6.0	0.66
TOTAL			12.0	2.54

* AC Base left after milling 2 inches with reduced structural coefficient

[t] From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

Subject: Pavement Design	Job No. CT052885.0001.00008	BY: CHKD:

Location: Blue Ridge Parkway, Section 2P
Milling and Overlay of Parking Lots and Overlooks
(i.e. Visitor Center, Balsam Gap, Bull Creek, Graybeard, Glassimine Falls, Lane Pinnacle, and Craggy Dome Lower Parking Area)

Average Daily Traffic:	1851
Design Road Life:	20
Annual % Growth:	2.0%
Terminal Servicibility:	2
Directional Factor:	50%
Lane Distribution Factor:	1.0

Regional Factor	1.5
In-situ CBR	10.0
Existing 6" Agg. Base CBR	50.0
Design Soil Support Value	6.1
Calculated Design Structural Number:	2

Vehicle Class	Percent of ADT	Growth Factor	Average Initial Truck Factor	Accumulated 18-kip ESALs over Performance Period
Automobiles	95.0%	24.29737	0.0004	3119
RVs / Light Trucks	3.0%	24.29737	0.2	49247
Bus	1.0%	24.29737	0.88	72229
Heavy Maint. Truck	1.0%	24.29737	0.6	49247
Total	100.0%			1.7E+05

Specified Layer Design

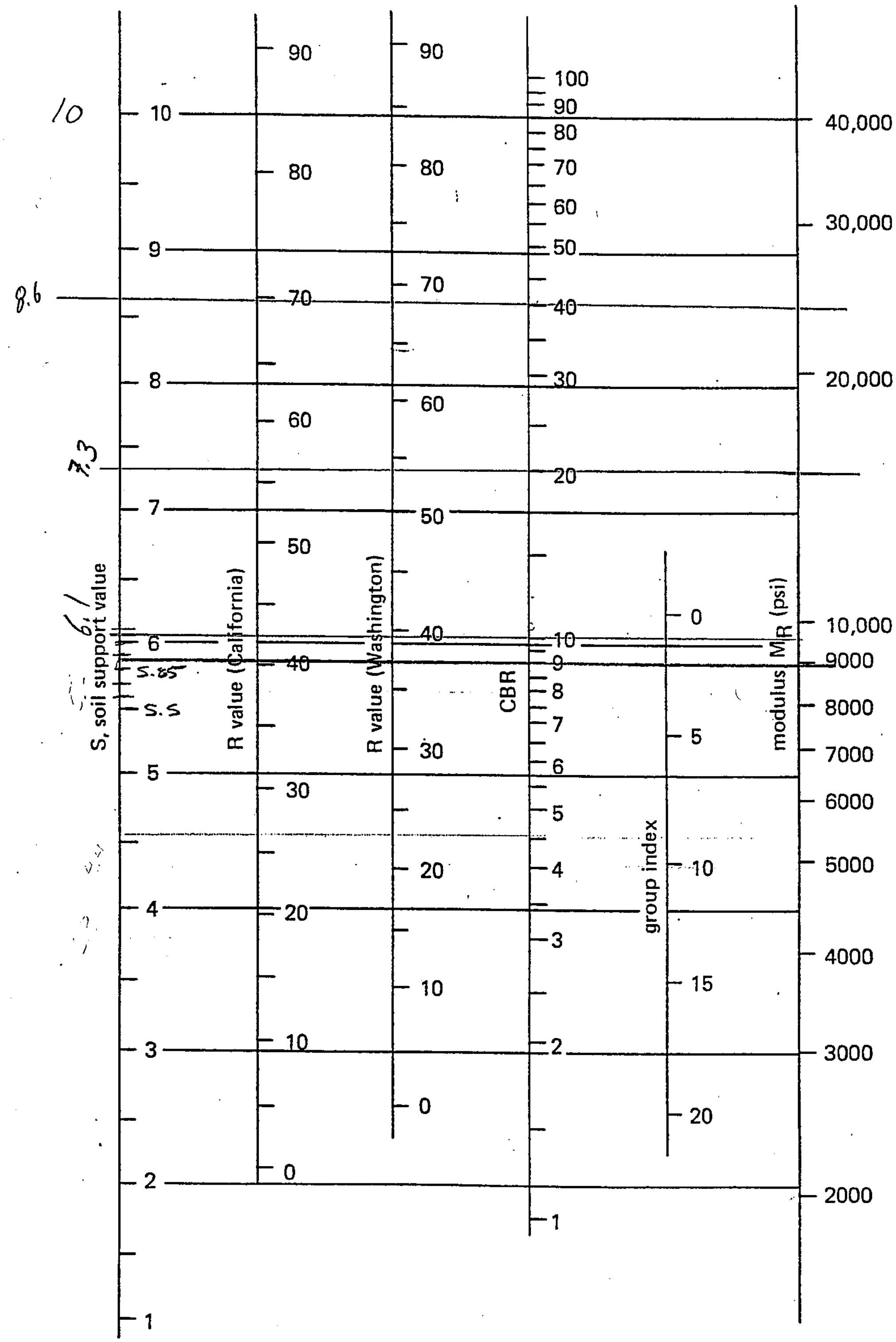
Layer	Material Description	Struct. Coef. (Ai)	Thickness (in)	Calculated SN
1	AC Surface	0.42	1.5	0.63
2	AC Binder#	0.34	2.0	0.68
3	AC Binder*	0.2	1.5	0.3
3	Agg. Base[t]	0.11	6.0	0.66
TOTAL			11.0	2.27

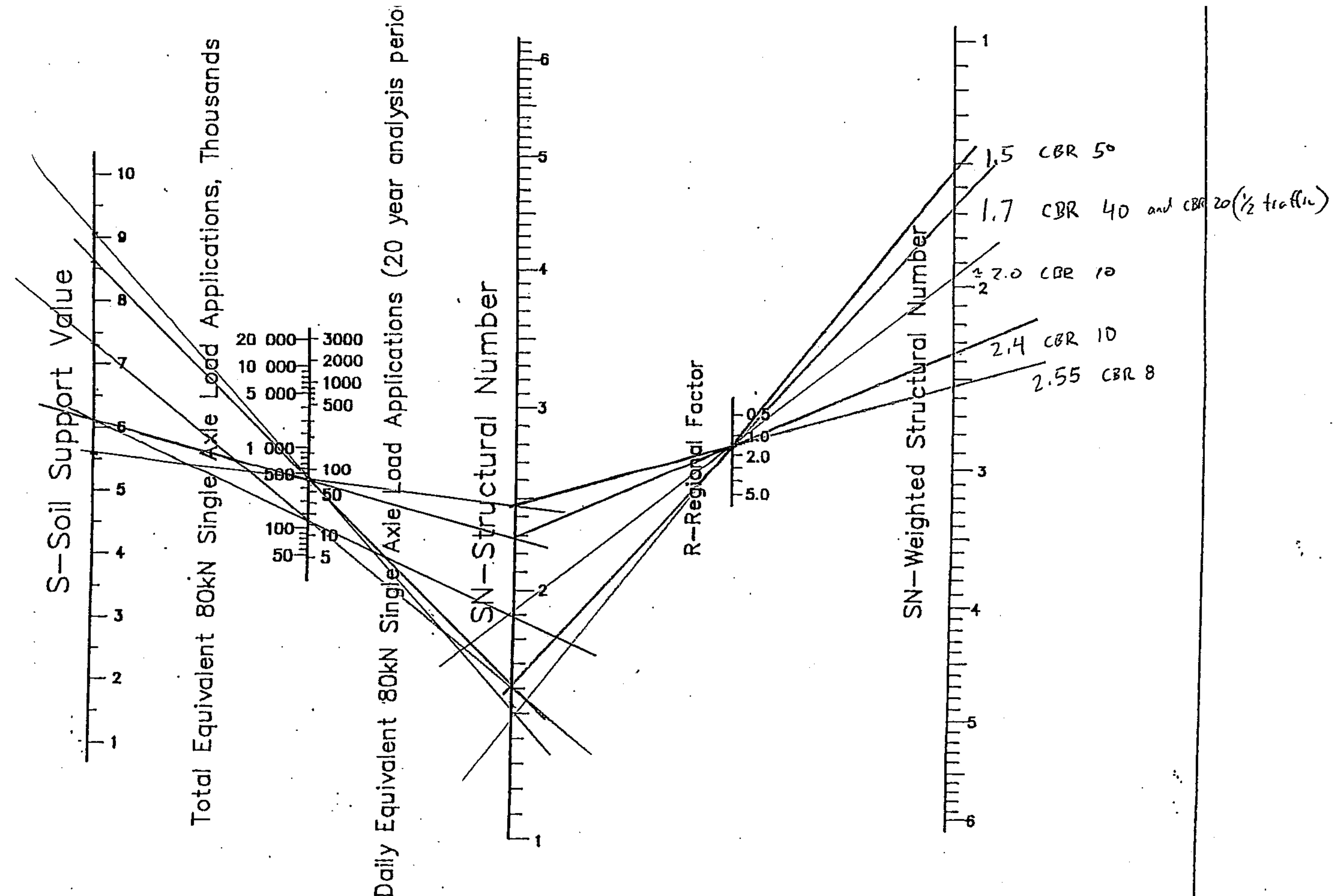
* Mill one inch leaving 1.5 inches

[t] From Fig 2.6. Variation in Granular Base Layer Coefficient, AASHTO Design of Pavement Structures 1993

 # The layer thickness is to be 3 to 4 times the NMSA of 3/4", therefore the AC Binder is to be 2.5"

Appendix B: Revised Soil Support Correlations





The chart requires two applications of a straightedge for each solution. First, the soil support value of the roadbed soil (on the left scale) and the total or daily equivalent 80kN/single-axle loads for the traffic analysis period (left side of second scale) are used to solve for the unweighted structural number (center scale). This unweighted structural number is used with the selected regional factor (4th scale) to solve for the design SN (right scale) applicable to the total pavement structure. Suitable designs are those whose combinations of materials types and thicknesses satisfy the general equation:

$$SN = a_1D_1 + a_2D_2 + a_3D_3$$

Exhibit 6.23 Design Chart for Flexible Pavements - $P_t = 2.0$

highway facilities a value of 2.5 is recommended while a $p_t = 2.0$ is suggested for lesser traffic volume roads. Normally, it is recommended that the p_t value selected should never be less than 2.0. For minor highways, the approach is to keep $p_t = 2.0$ but reduce the traffic analysis time period.

Equivalent Wheel Load Repetitions (W_{t18}). For the AASHO design method, mixed traffic within a given period of time (termed the traffic analysis period) is accounted for by equivalent damage factors relative to the standard 18-kip single-axle load (Chapter 4).

Traffic may be equated to daily 18-kip load applications if a common 20-year traffic analysis period is selected, or it may be expressed as the total 18-kip load applications within the traffic analysis period. As can be seen from Table 4.9, the equivalency factors, and hence W_{t18} applications, are a function of p and SN. For most design problems, a SN value of 3.0 may be assumed for the equivalency analysis. This value will normally result in an overestimation of the W_{t18} but in general, the resulting error will be insignificant.

Regional Factor (R). As noted previously, the regional factor was placed into the AASHO design procedure to allow for its use in climatic environments other than the one that existed during the Road Test. In its present form, the R value constitutes a fairly significant input value but unfortunately is one that, at present, is not well documented. Based upon an analysis of the Road Test results dealing with the rate of loss of serviceability during various climatic periods during the testing, typical values of R were developed by the AASHO guide. These values are shown in Table 15.1.

TABLE 15.1. Regional Factors[a]

Condition	R value
Roadbed materials frozen to depth of 5 in. or more	0.2–1.0
Roadbed materials dry, summer and fall	0.3–1.5
Roadbed materials wet, spring thaw	4.0–5.0

[a] From AASHO Interim Guide.

Based upon an NCHRP state evaluation study of the AASHO design guide (21), a generalized R value contour map has been developed for the U.S. and is shown in Figure 15.2. The limitations of such a generalized map should be obvious. In most cases, the selection of the proper R value must be based upon the local conditions of the highway in combination with the judgement of an experienced engineer. The recommended range in R by the AASHO design guide for U.S. conditions is from 0.5 to 4.0.

Structural Number (SN). The SN is defined as an index number derived from an analysis of traffic, road-bed soil conditions, and regional factor that may be converted to thickness of various flexible-pavement layers through the use of suitable layer coefficients related to the type of material being used in each layer

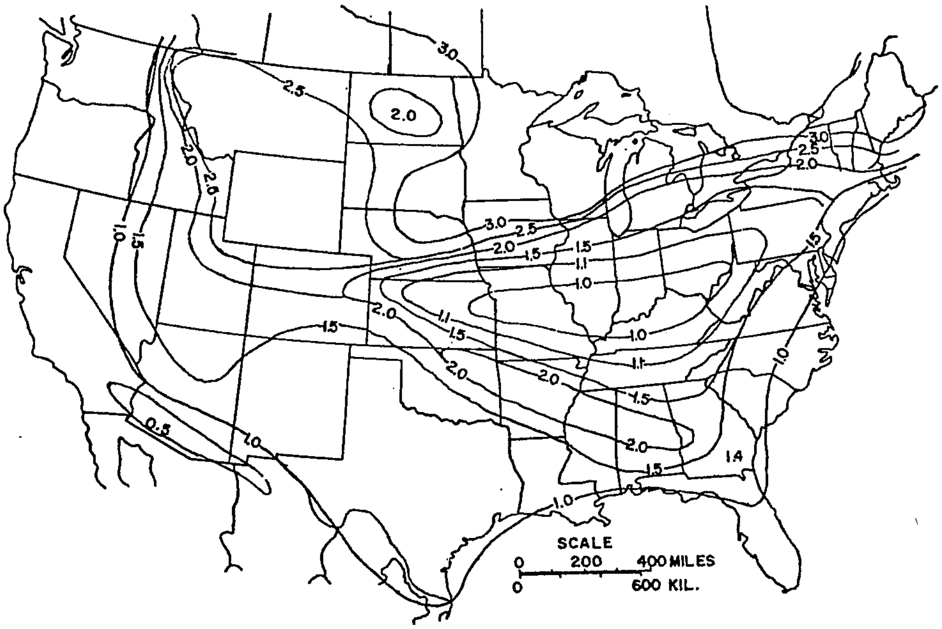


Figure 15.2. Generalized regional map of the United States. (From Van Til et al., NCHRP 128.)

of the pavement structure The layer coefficient (designated by a_1, a_2, and a_3, for surface, base and subbase, respectively) is the empirical relationship between SN for a pavement structure and layer thickness, which expresses the relative ability of a material to function as a structural component of the pavement (1).

Analytically, the SN is given by

$$SN = a_1D_1 + a_2D_2 + a_3D_3 \tag{15.9}$$

where the D_i values are the respective layer thicknesses.

At the AASHO Road Test, four types of basic materials were used in the study: crushed stone, gravel, cement-treated gravel, and bituminous-treated gravel. Based upon the results of the study along with an estimation from results of special base studies at the test, layer coefficients were established by the AASHO Committee on Design and are shown in Table 15.2.

Since the initial publication of the layer coefficients shown in Table 15.2, several state highway departments and trade agencies have developed their own layer coefficients for materials commonly used by their respective agencies. Based upon the NCHRP evaluation study of the AASHO design guide (21), nomographic solutions of the layer coefficients have been proposed from a combined analysis of individual state highway results and a theoretical multilayered elastic analysis. These nomographs are shown in Figure 15.3 and are presented as guides in assessing relative changes in the a_i values as the measured test response of the material varies.

Since the solution of the AASHO equation results in a design SN, it should be realized that any combination of layer thicknesses and material types satisfying